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VIBRATION MEASUREMENTS OF CW 454 SONAR DOME.(U)
JAN 65 G OGLE
UNCLASSIFIED BNS-R-48 NL

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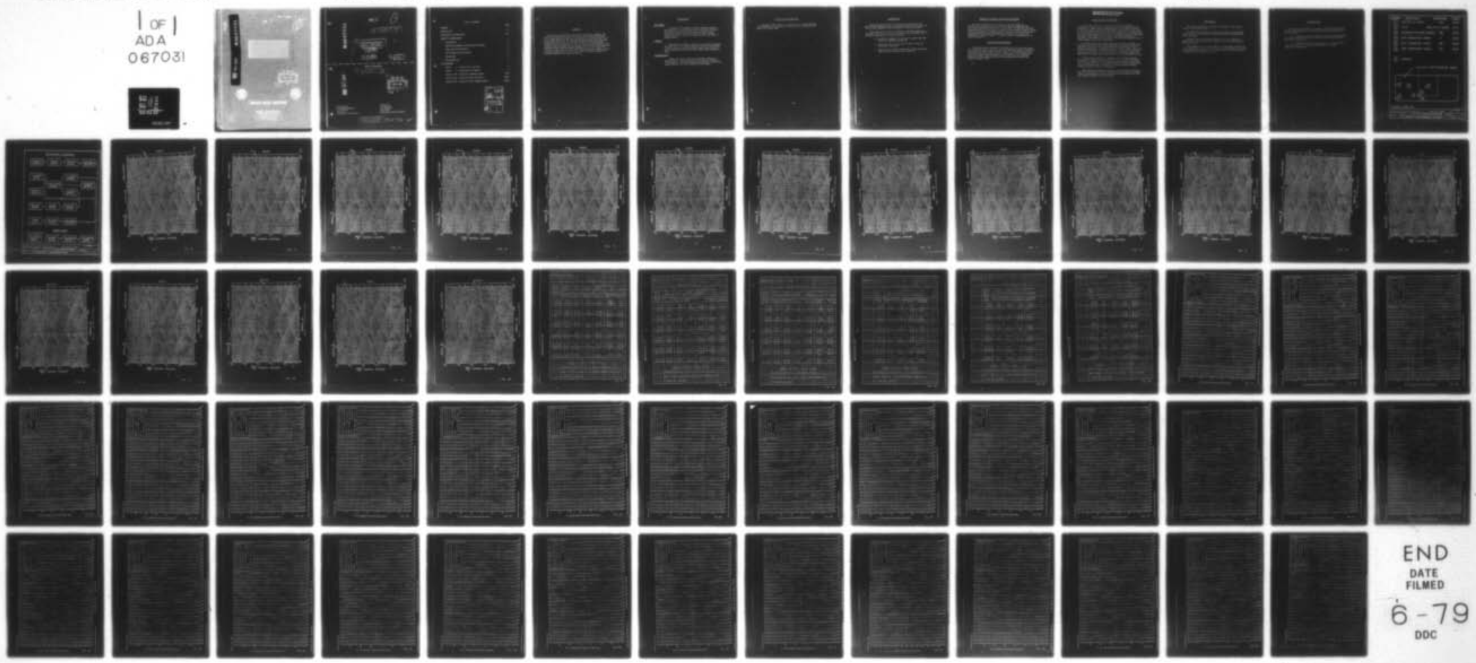

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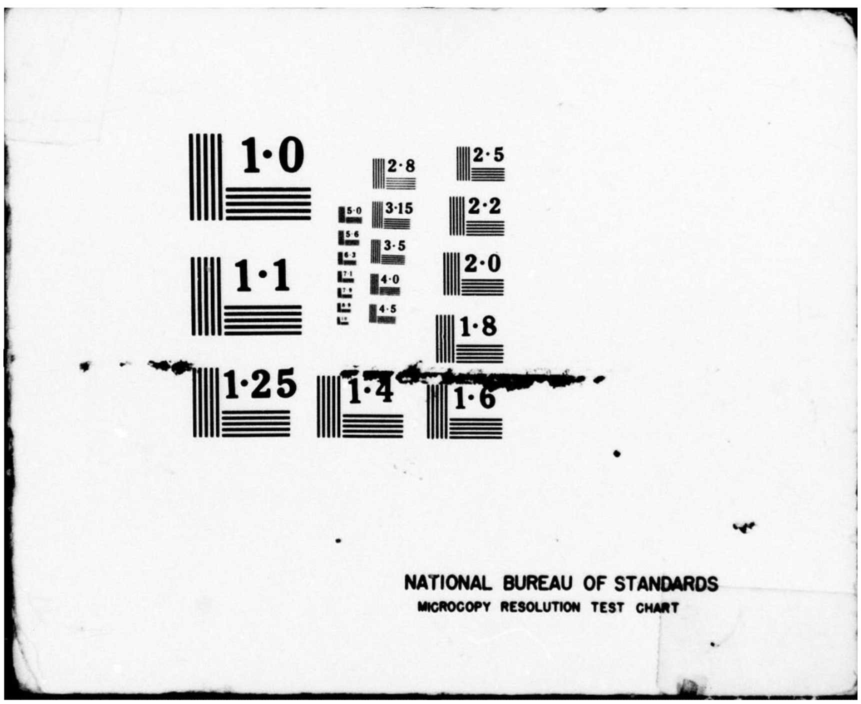
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MICROCOPY RESOLUTION TEST CHART

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6 VIBRATION MEASUREMENTS OF CW 454 SONAR DOME.

EVALUATION REPORT R-48

11 JAN 1965

BY

10 G./OGLE

12 67p.

APPROVAL INFORMATION

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ABSTRACT

Vibration investigations consisting of mechanical impedance and decay rate studies were conducted on the modified USN/USL furnished CW 454 Sonar Dome at Boston Naval Shipyard prior to installation on the U.S.S. WITEK (EDD 848). The surveys included impedance and decay rate measurements on the dome "in air" and "in water", with and without AN/SQS-23 transducer installed as well as decay rate measurements on the installed dome in drydock and at pierside. The results of the mechanical impedance survey show the transfer impedances to be very high for a structure of this type while the decay rate tests show no simple, direct correlation between the "in air" to "in water" conditions except the increased damping for a submerged dome.

SUMMARY PAGE

THE PROBLEM

To measure the mechanical transfer impedance behavior and decay rates of the modified CW 454 dome in the frequency range of 200-8000 cps and to determine if there is any correlation between the "in air" and "in water" findings so as to establish a norm of measurement for future domes of similar design.

FINDINGS

The mechanical transfer impedance is very high, the decay rates are high in the higher frequency range and there appears to be no simple, direct correlation between "in air" and "in water" measurements except the added damping when submerged in water.

RECOMMENDATIONS

Conduct at least two (2) more controlled studies on similar domes to insure repeatability of data and standards of measurement. Correlate underway measurements of decay rates held by USN/USL with data furnished in this report.

ADMINISTRATIVE INFORMATION

The Boston Naval Shipyard was authorized to conduct vibration investigations on a modified CW 454 Sonar Dome by USN/USL ltr ser 932-91 of 17 April 1963.

INTRODUCTION

The CW 454 Sonar Dome investigations were conducted at the Boston Naval Shipyard (8 Sept to 16 Oct 1964) under the direction of the U.S. Navy Underwater Sound Laboratory of New London, Conn.

The survey work consisted of mechanical impedance studies and decay rate tests on the modified dome (furnished by USN/USL) prior to and after installation on WITEK as follows:

a. Mechanical impedance "in air" and "in water" with and without the AN/SQS-23 transducer.

b. Decay rate tests "in air" and "in water", with and without the transducer.

c. Decay rate tests after installation of dome and transducer on ship in drydock and at pierside.

MECHANICAL IMPEDANCE INVESTIGATION PROCEDURE

To induce structure borne vibrations a 25# Ling Shaker was mounted on the forward top side of the dome through an Endevco force gage which monitored the force imput to the dome. The dome was supported on nylon pendants (in air and in the water) while transfer impedance measurements were recorded. A frequency scan in the range of 20 to 7000 cps was accomplished with Endevco accelerometers secured to the dome and the transducer as shown in figure 1. A system diagram of instrumentation is shown on figure 2.

DECAY RATE TEST PROCEDURE

An electric hammer (furnished by USN/USL) was mounted on the inside of the dome and used to excite the dome and transducer natural frequencies. The results of these excitations were monitored by accelerometers whose signal were filtered in third octaves. These signal were displayed and analyzed through a frequency range of 200 to 8000 cps on a Tektronix Memoscope, Accelerometer locations and instrumentation utilized are shown on figures 1 and 2.

DATA ANALYSIS AND DISCUSSION

The transfer mechanical impedance of the tested locations throughout the range of 20 to 7000 cps are shown in figures 3 through 20 inclusive. There is no appreciable change between the "in air" and "in water" transfer impedance measurements at positions 1, 2 and 3 prior to the installation of the transducer. The addition of the transducer to the system alter appreciably the transfer impedance response at all tested locations. Additionally, the "in water" measurements indicate the presence of anti-resonance peaks at 200, 270, and 1500 cps which are not evident during the "in air" measurements.

The decay rates of the tested locations throughout the range of 200 to 8000 cps (third octave bands) are shown in figures 21 through 26 inclusive. There is a noticeable difference in the decays at each position depending on the condition such as: with or without transducer, "in air" or "in water". The changes are of a random nature and do not lend themselves to any sort of basic pattern. Generally speaking the decay rates "in water" are slightly higher than the decay rates "in air".

Percent critical damping vs frequency for the tested locations throughout the range of 200 to 8000 cps is shown in figures 27 through 56 inclusive. Inasmuch as the percent critical damping is calculated from the decay rate the changes under various conditions is again noted to be of a random nature. Generally, the percent critical damping increases for all "in water" measurements.

There were many resonances recorded on the decay rate tests which were not evident in the transfer mechanical impedance survey indicating that all the resonances could not be excited by the shaker due to the high transfer impedance of the structure.

CONCLUSIONS

The transfer mechanical impedance, as measured on this complex structure is relatively high.

The decay rate measured on the skin of the dome is considerably less than that of the transducer ring.(The dome skin contributes very little damping).

Because of the similarity and spacing of the dome supporting members whole families of natural frequencies were excited during the decay rate tests.

There appears to be no simple and direct relationship between any of the conditions: it is not apparent how we could predict the "on ship in the water" dome performance if furnished only the "in air" data of the decay rates or impedance history.

RECOMMENDATIONS

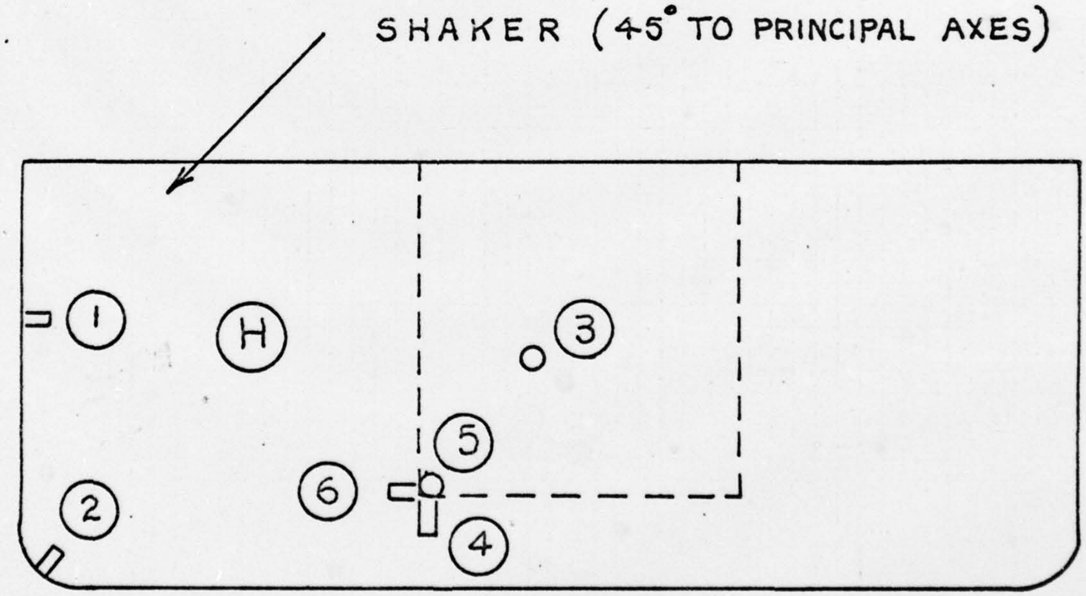
The following recommendations are made in the interest of a more thorough understanding of the vibration resonance and decay rate of the CW 454 dome.

a. Correlate underway measurements of decay rates (furnished to USN/USL by COMNAVSHIPYD BSN ltr DD848 of 30 Dec 1964) with data furnished in this report.

b. Conduct similar controlled studies on at least two (2) other domes "in air" to establish repeatability of data and standards of measurement.

NUMBER	LOCATION	DIRECTION	TYPE*
1	CENTER OF NOSE	F/A	2226
2	CHIN	VERTICAL TO PLANE	2219
3	CENTER OF FLAT VERT. SURFACE	P/S	2226
4	BTM. TRANSDUCER FRAME	V	2219
5	BTM. TRANSDUCER FRAME	P/S	2219
6	BTM. TRANSDUCER FRAME	F/A	2219
H	HAMMER		

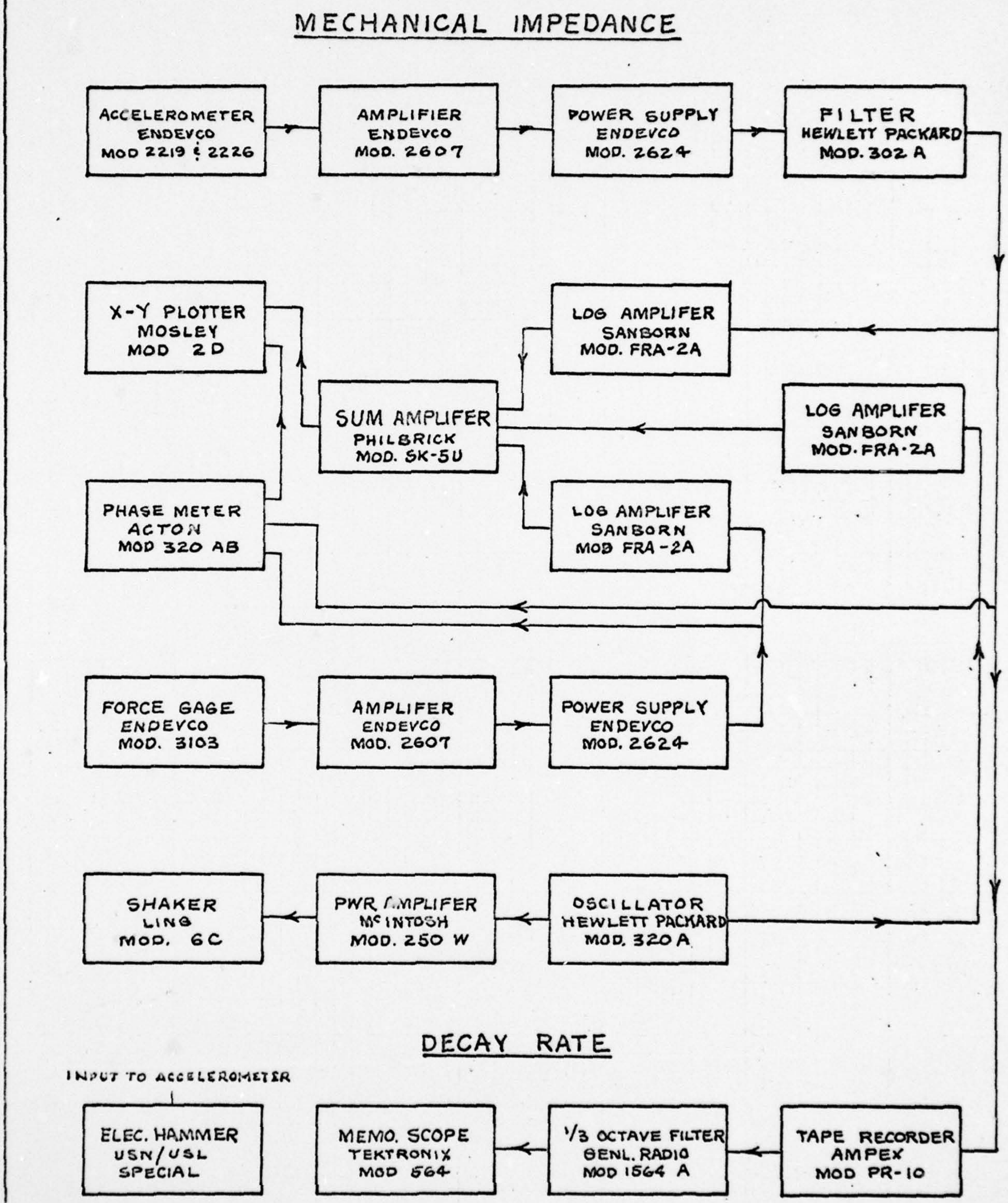
SHAKER (45° TO PRINCIPAL AXES)



* ENDEVCO MODEL NO.

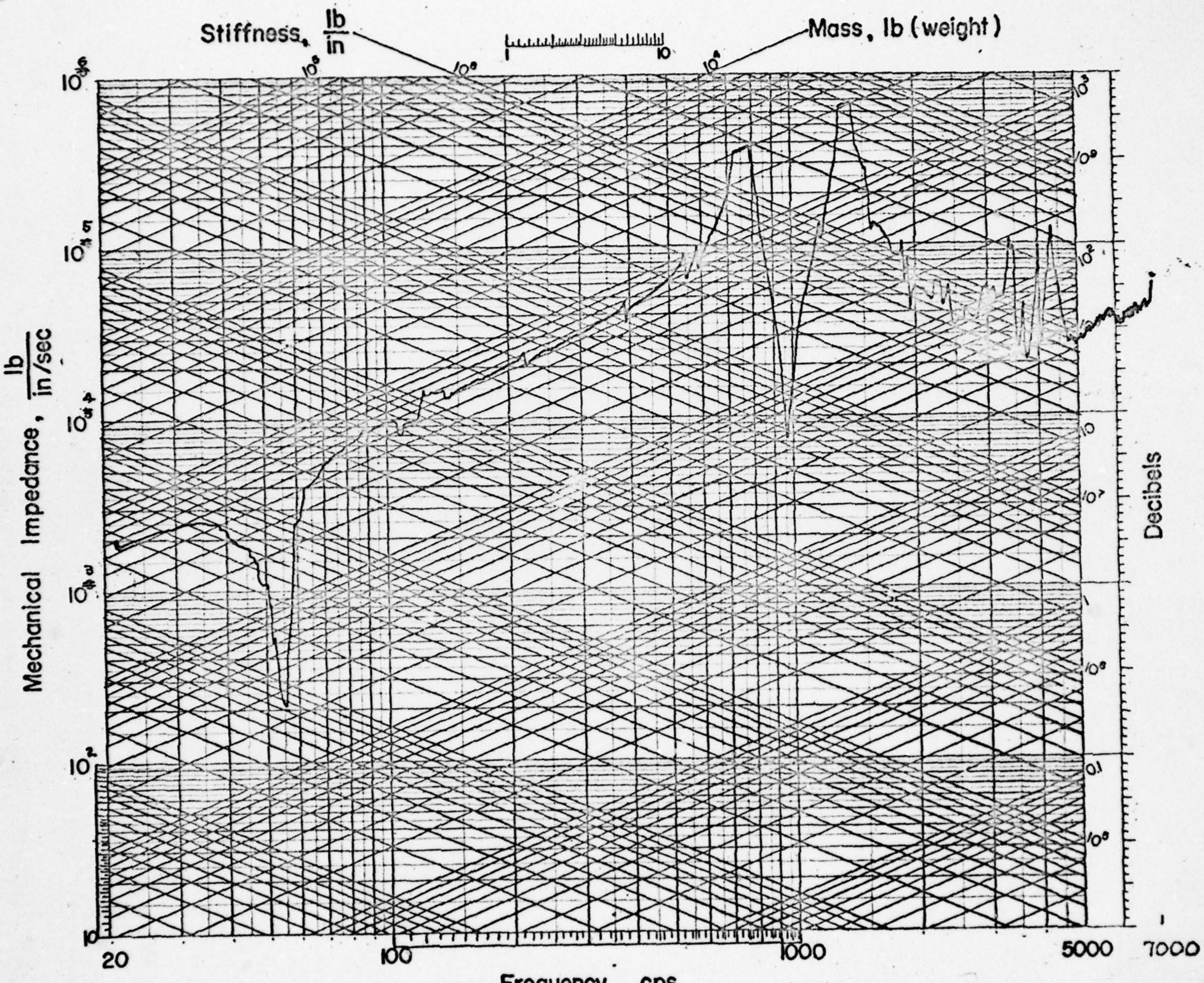
DESIGN CALCULATION SHEET 1ND-BSNNS-1429 (6-61)		BOSTON NAVAL SHIPYARD	CODE 265
BY	CHKD	SHIP OR PROJECT U.S.S. WITEK (EDD 848)	FIGURE 1
APPVD	DATE 12 JAN 65	SUBJECT ACCELEROMETER LOCATIONS	SHEET 1 OF 1

FIG. 1



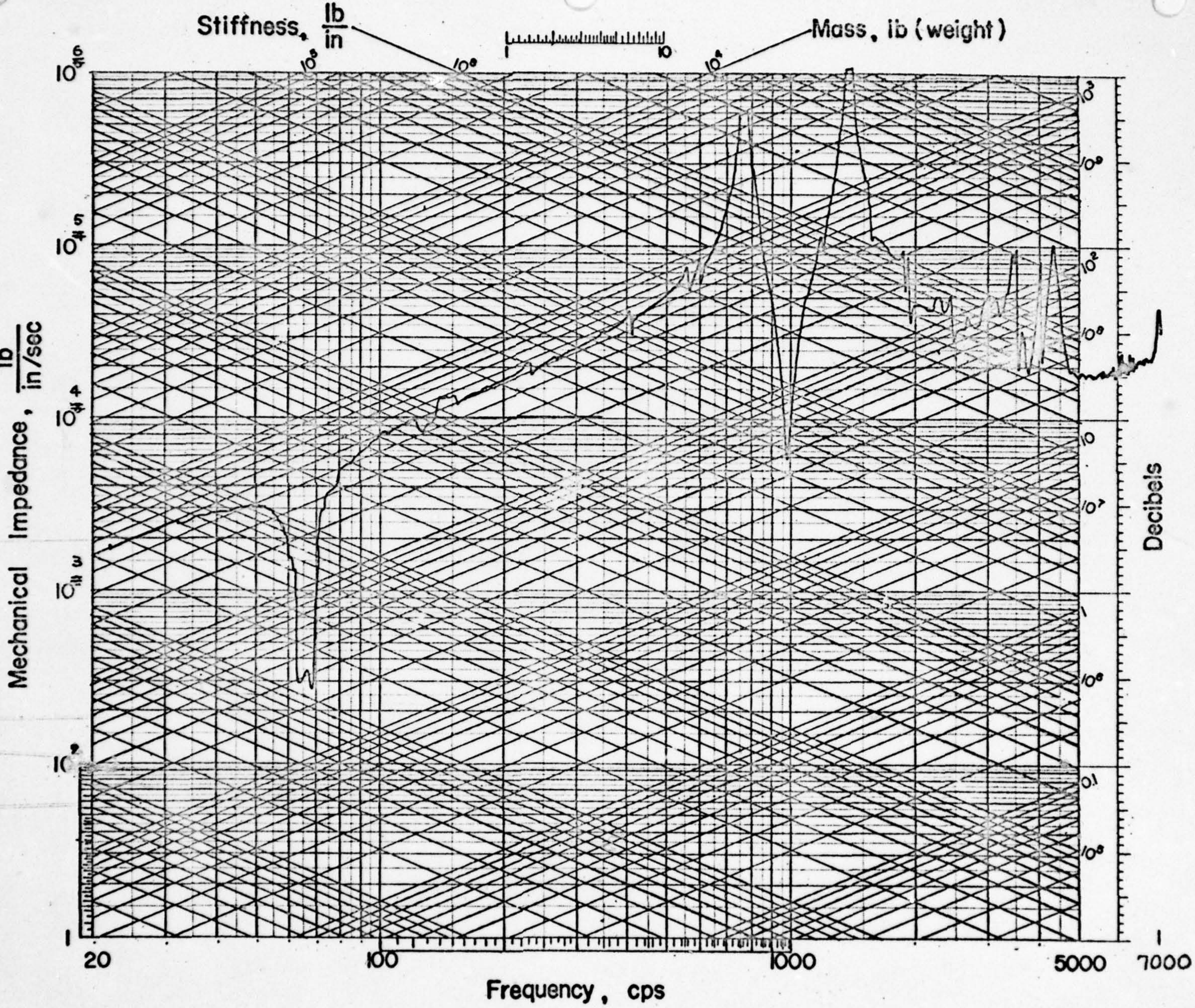
DESIGN CALCULATION SHEET IND.-BSNNS-1429 (6-61)		BOSTON NAVAL SHIPYARD	CODE 265
BY	CHKD	SHIP OR PROJECT U.S.S. WITEK (EDD 848)	FIGURE 2
APPVD	DATE 12 JAN 65	SUBJECT INSTRUMENTATION	SHEET 1 OF 1

FIG. 2



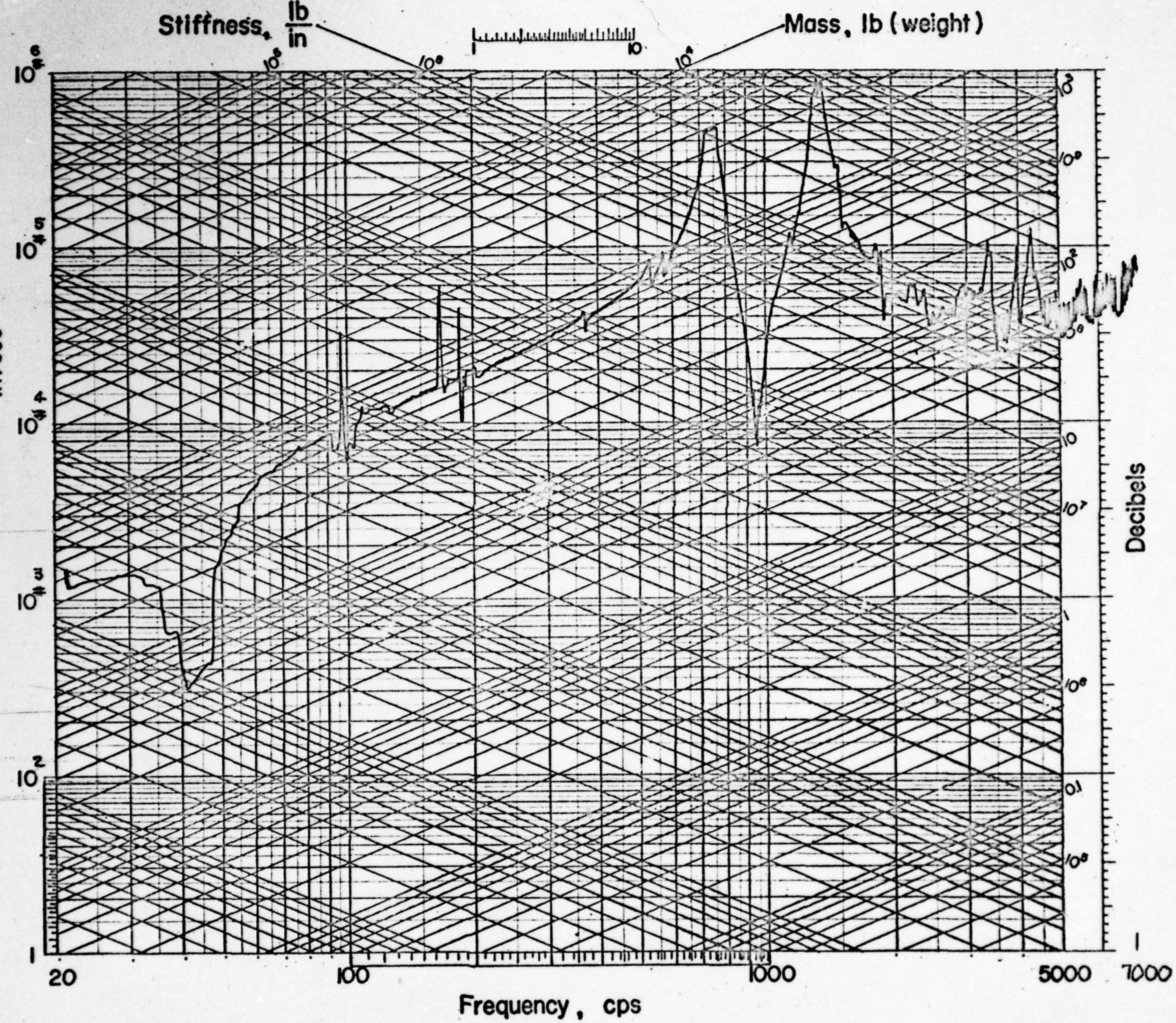
POSN. 1 IN AIR NO TRANSDUCER

FIG 3



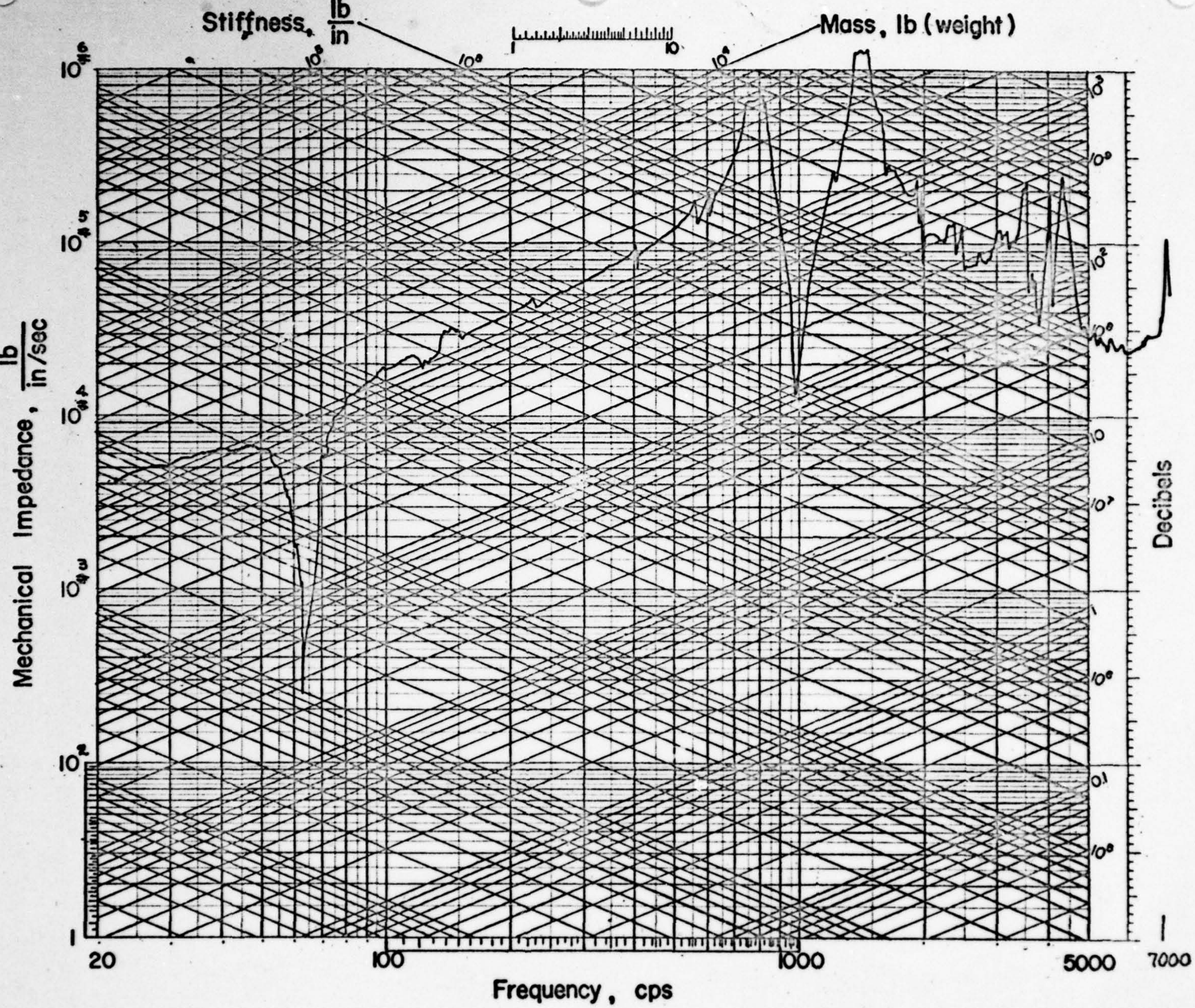
POSN. 1 IN WATER NO TRANSDUCER

FIG. 4



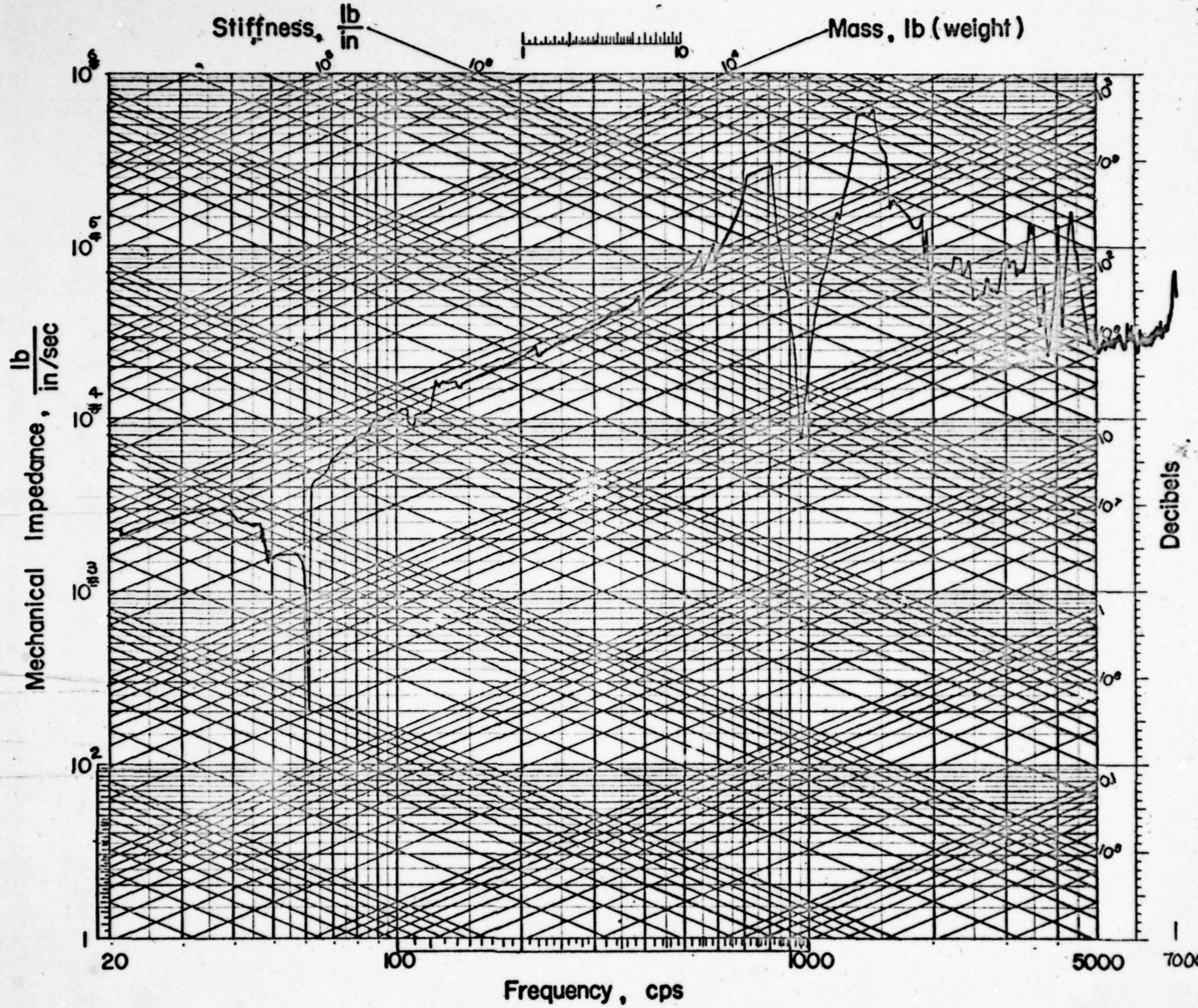
POSN. 2   IN AIR NO TRANSDUCER

FIG. 5



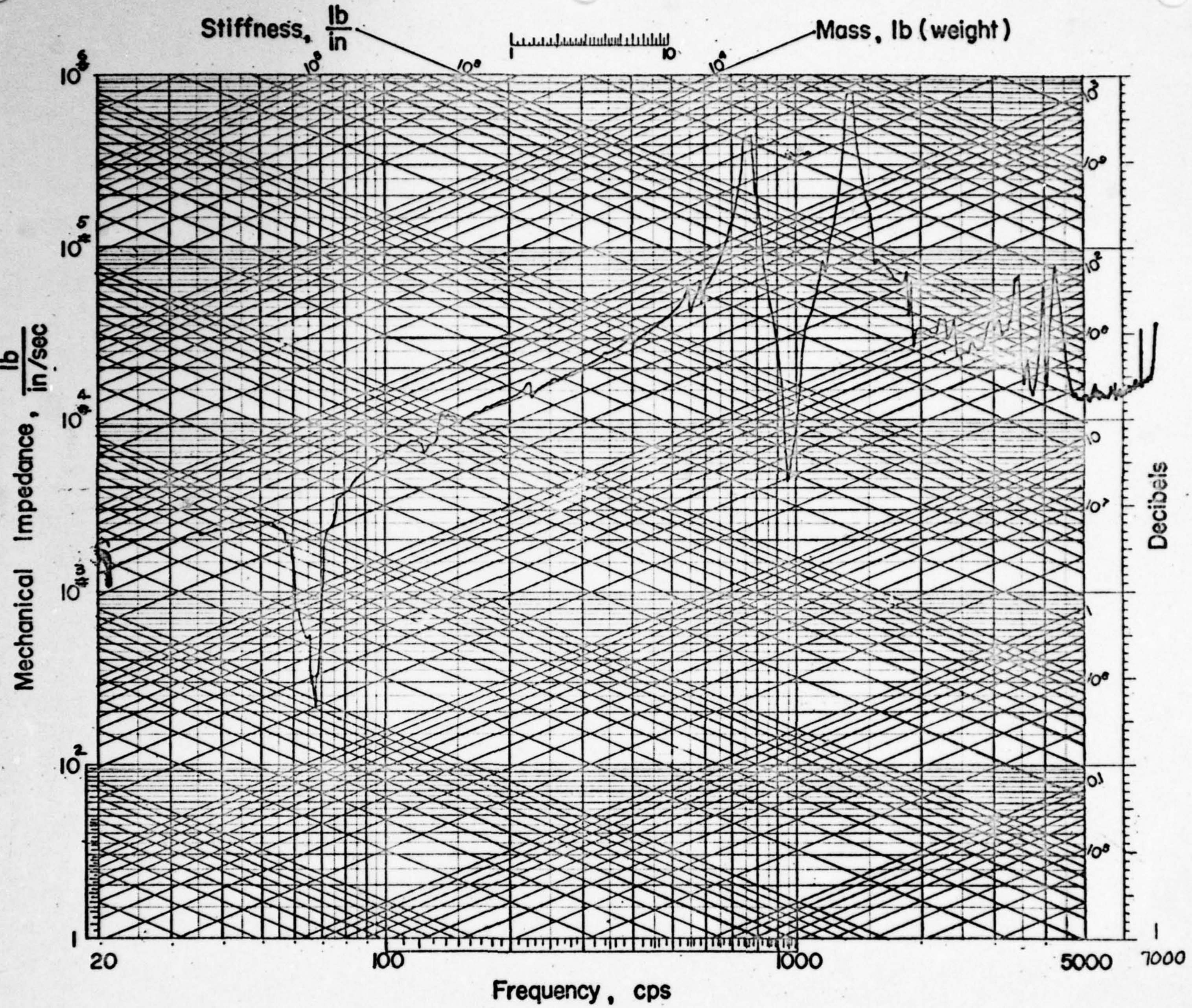
POSN 2 IN WATER NO TRANSDUCER

FIG. 6



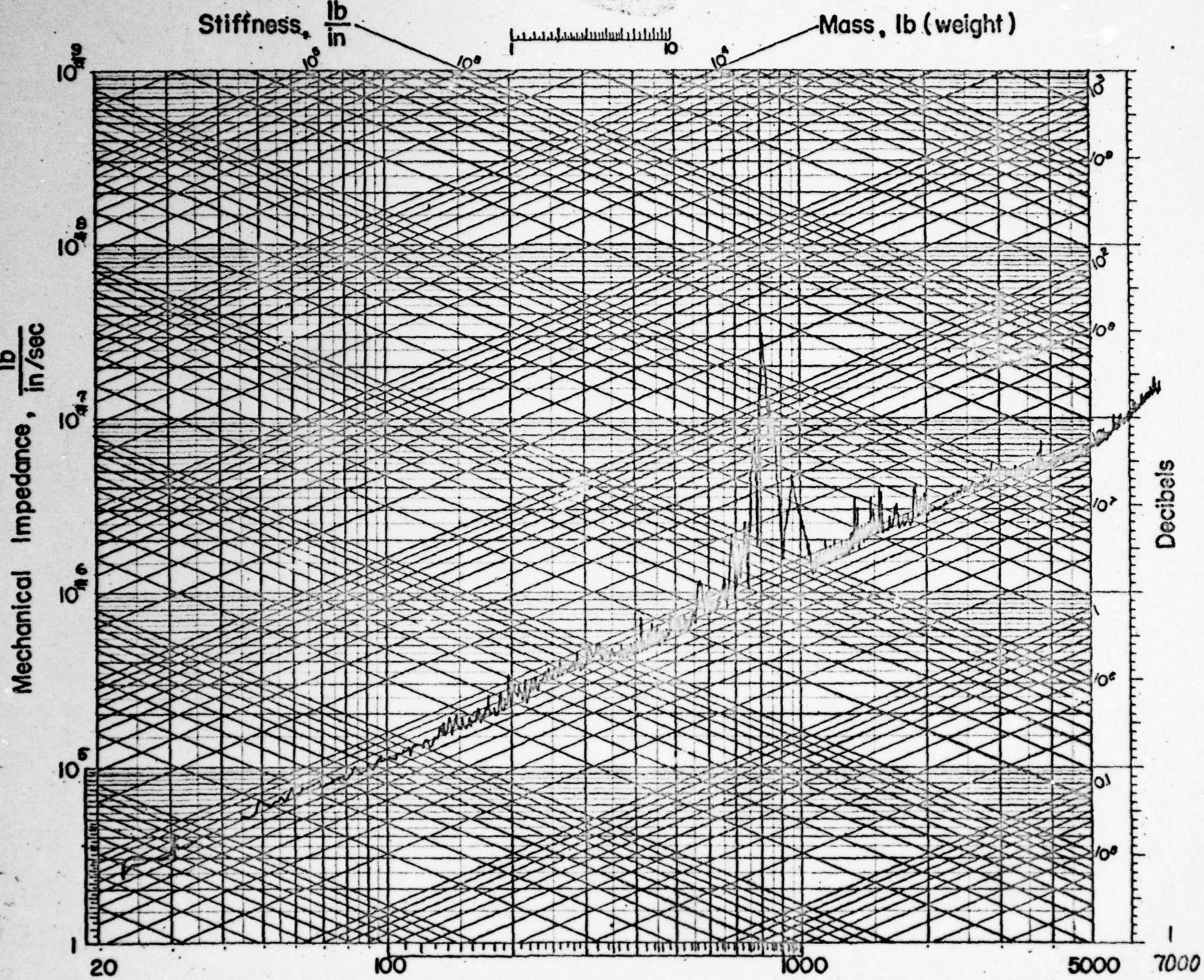
POSN. 3 IN AIR NO TRANSDUCER

FIG. 7



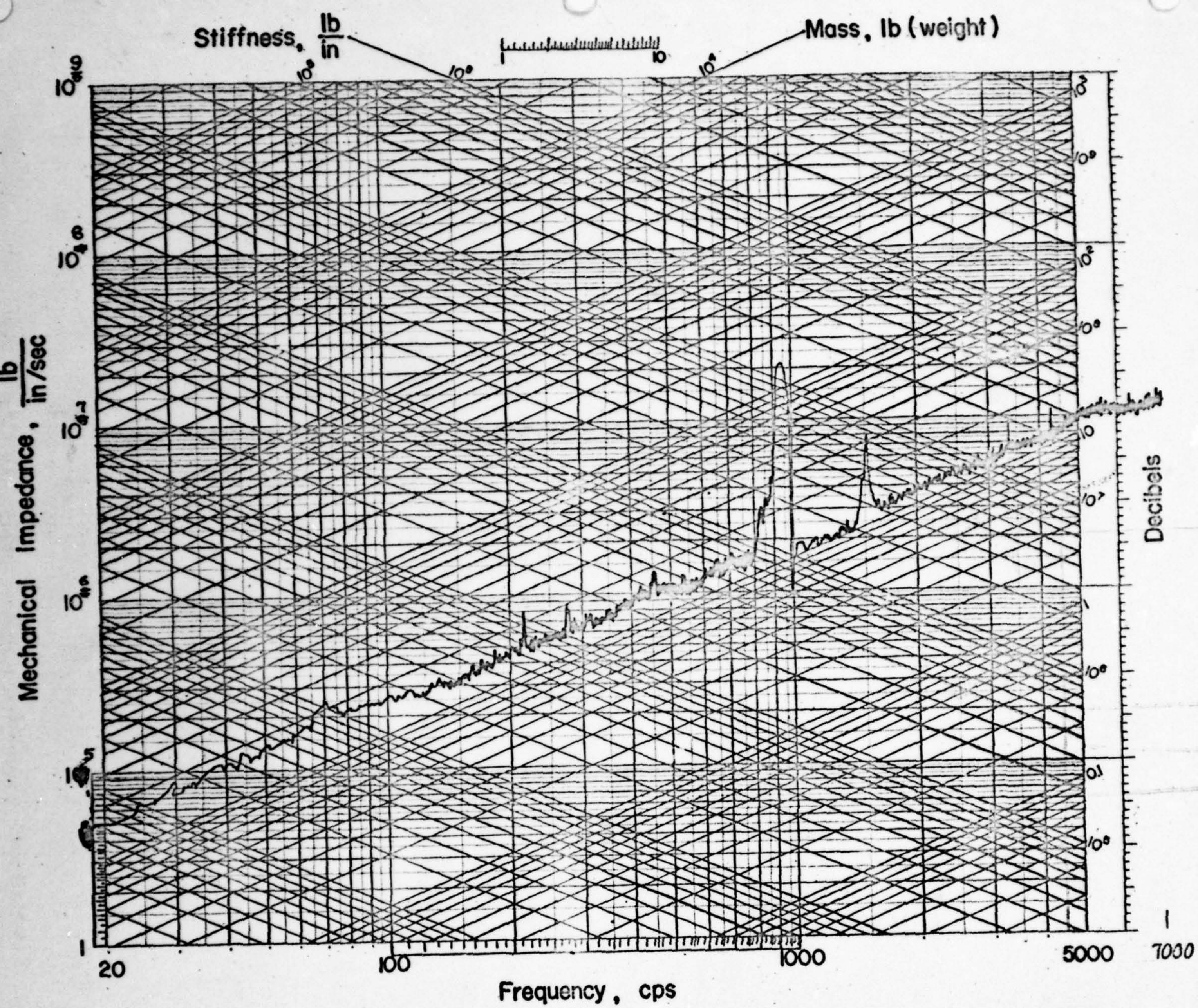
POSN. 3 IN WATER NO TRANSDUCER

FIG. 8



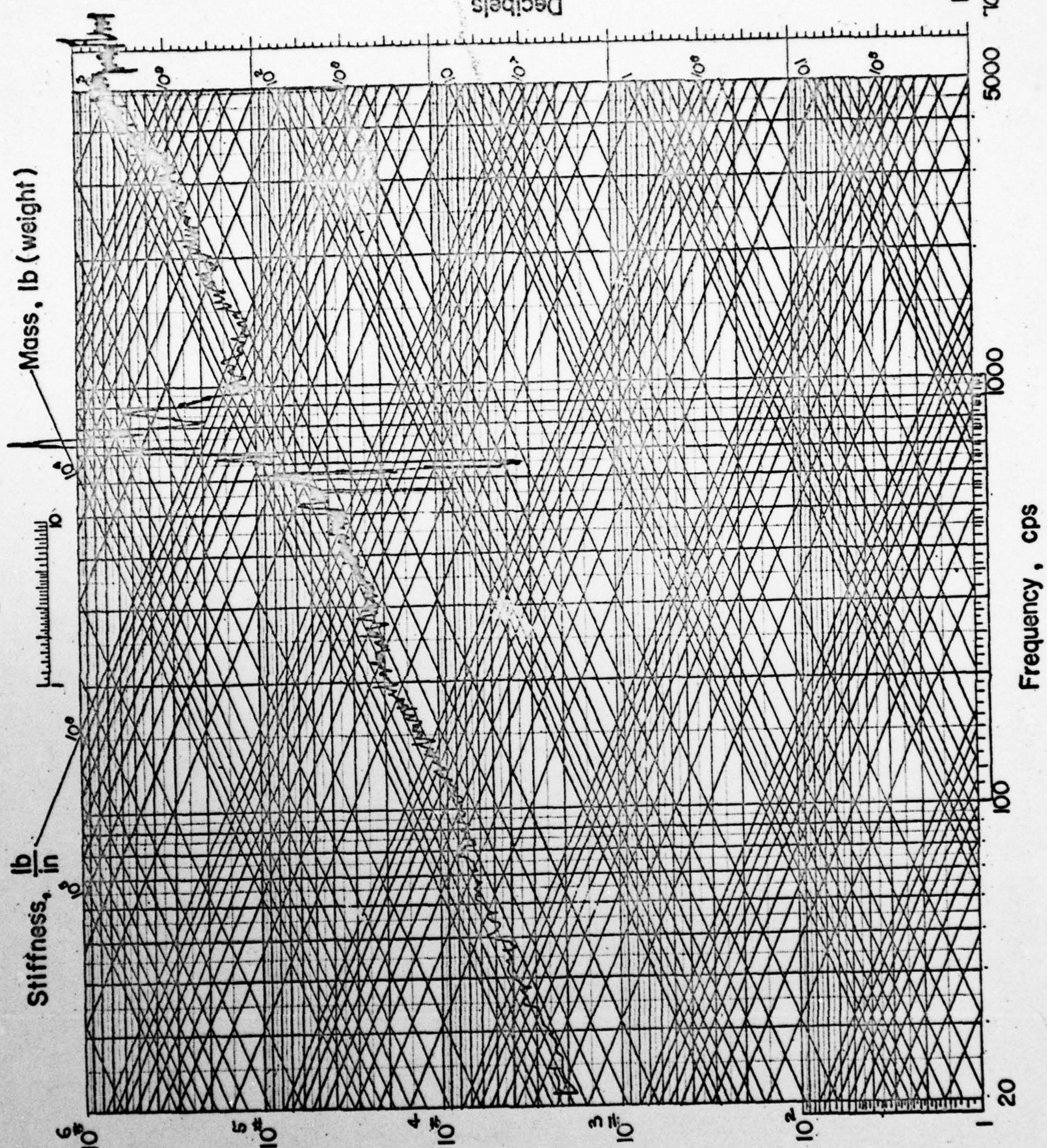
POSN. 1 IN AIR WITH TRANSDUCER

FIG. 9



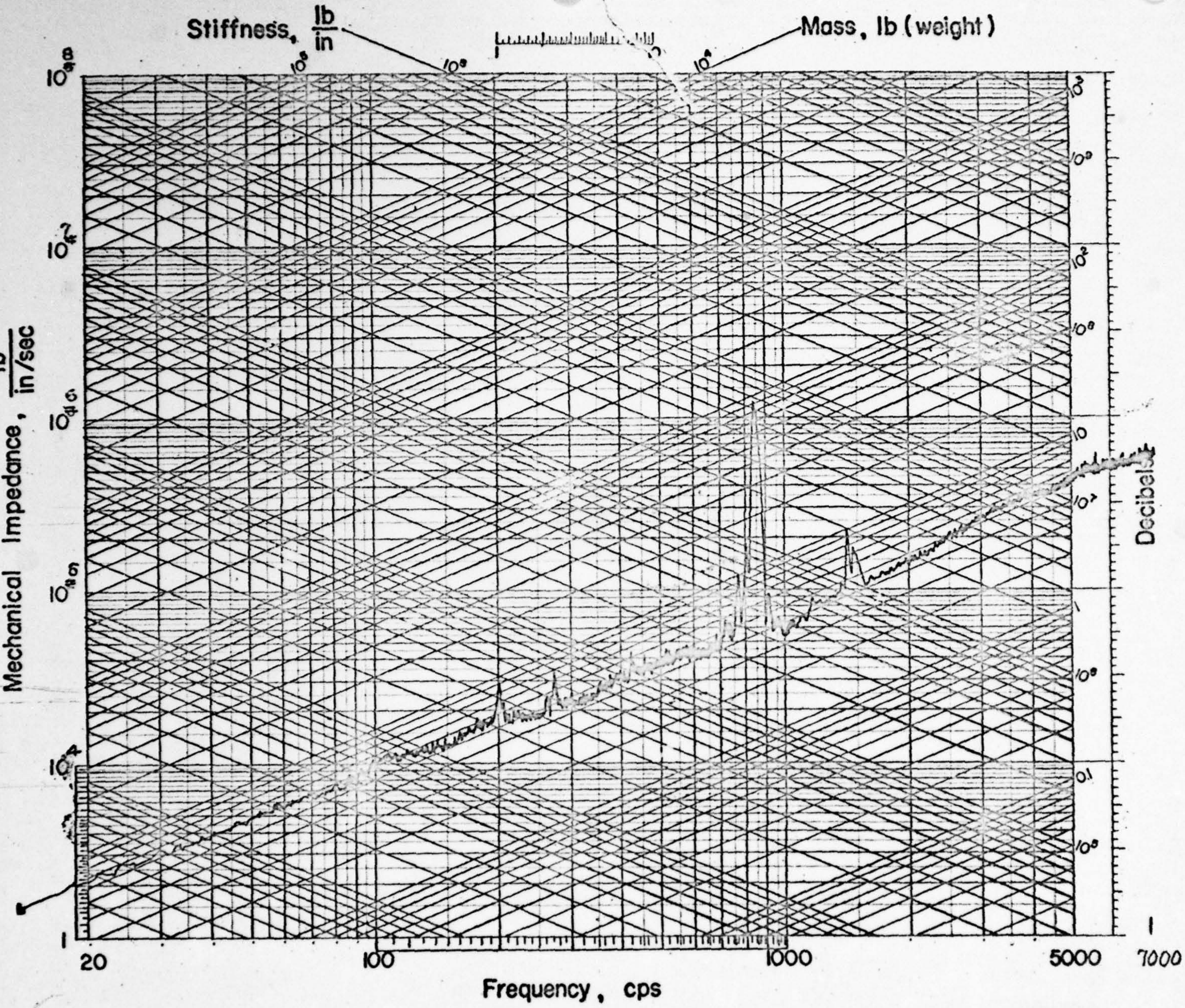
POSN. 1 IN WATER WITH TRANSDUCER

FIG. 10



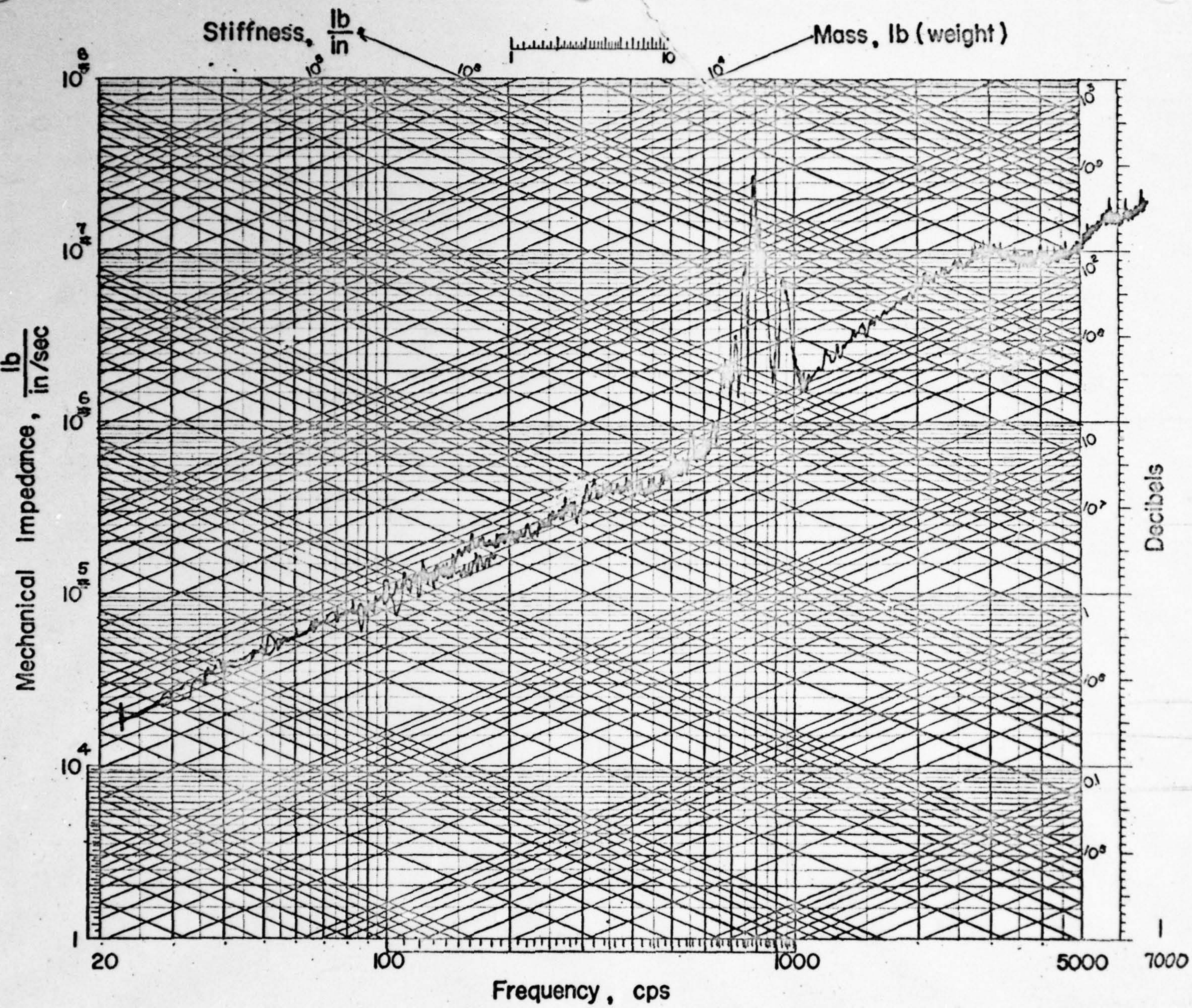
POSN. 2 IN AIR WITH TRANSDUCER

FIG. 11



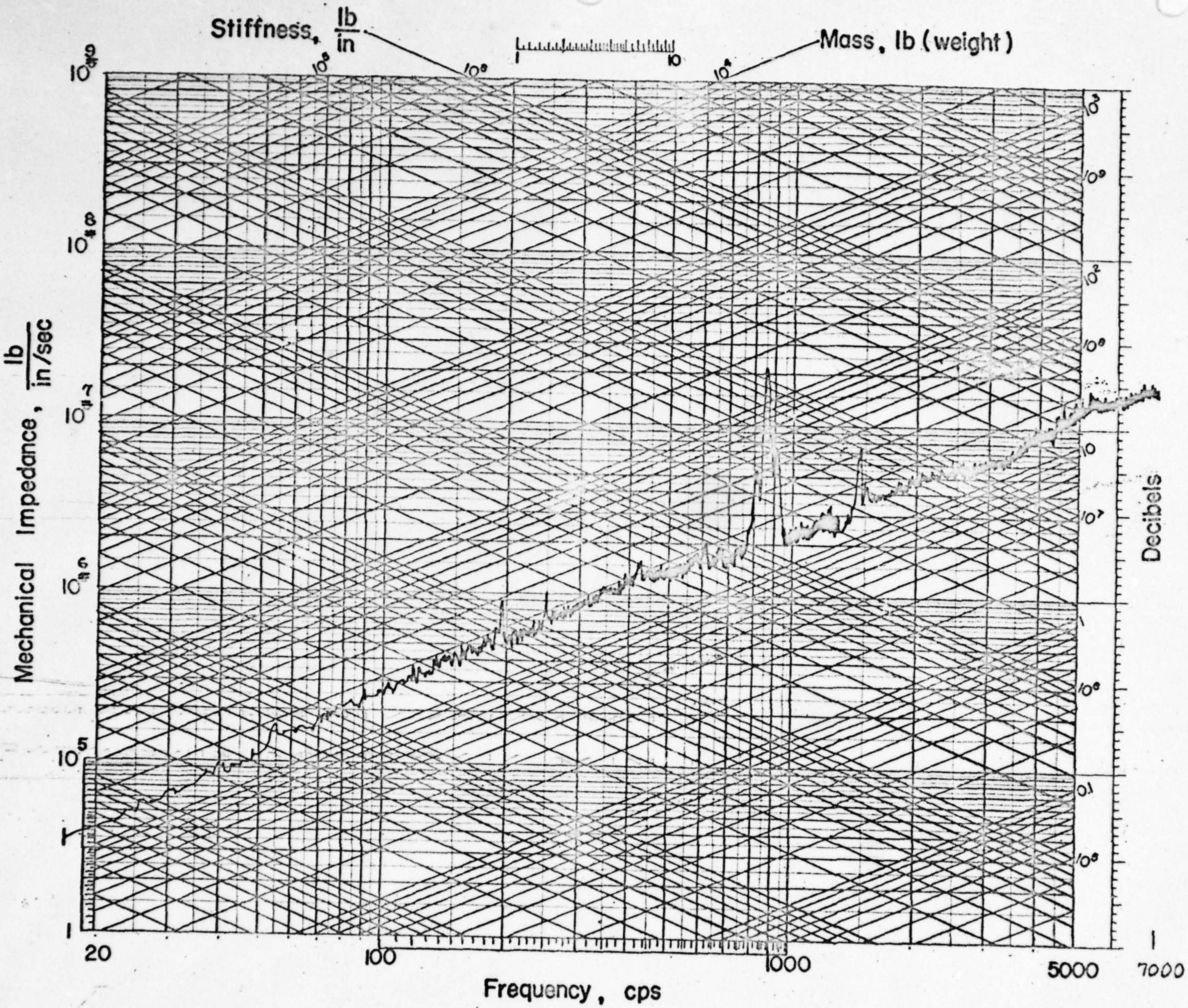
POSN. 2 IN WATER WITH TRANSDUCER

FIG. 12



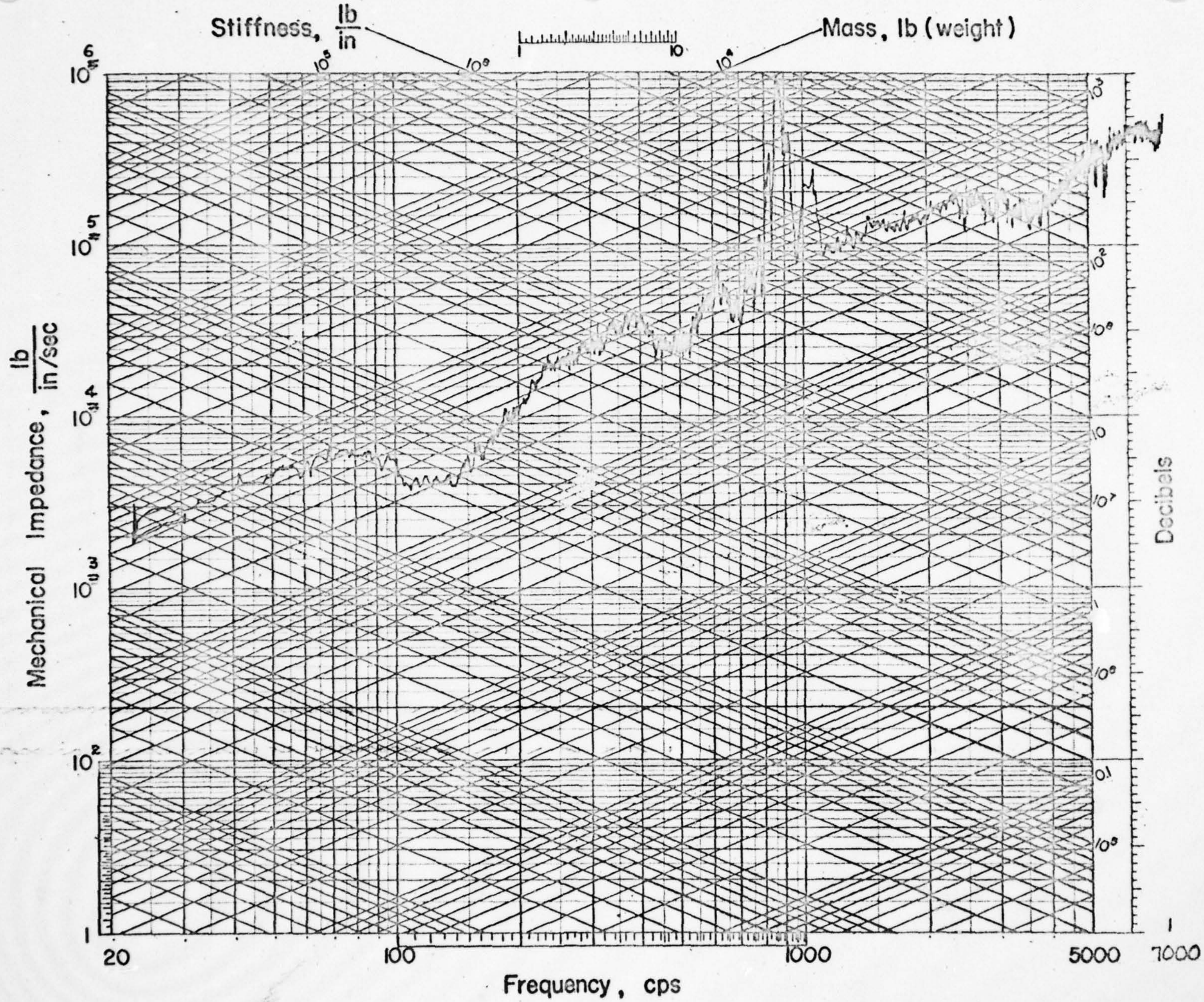
POSN. 3 IN AIR WITH TRANSDUCER

FIG. 13



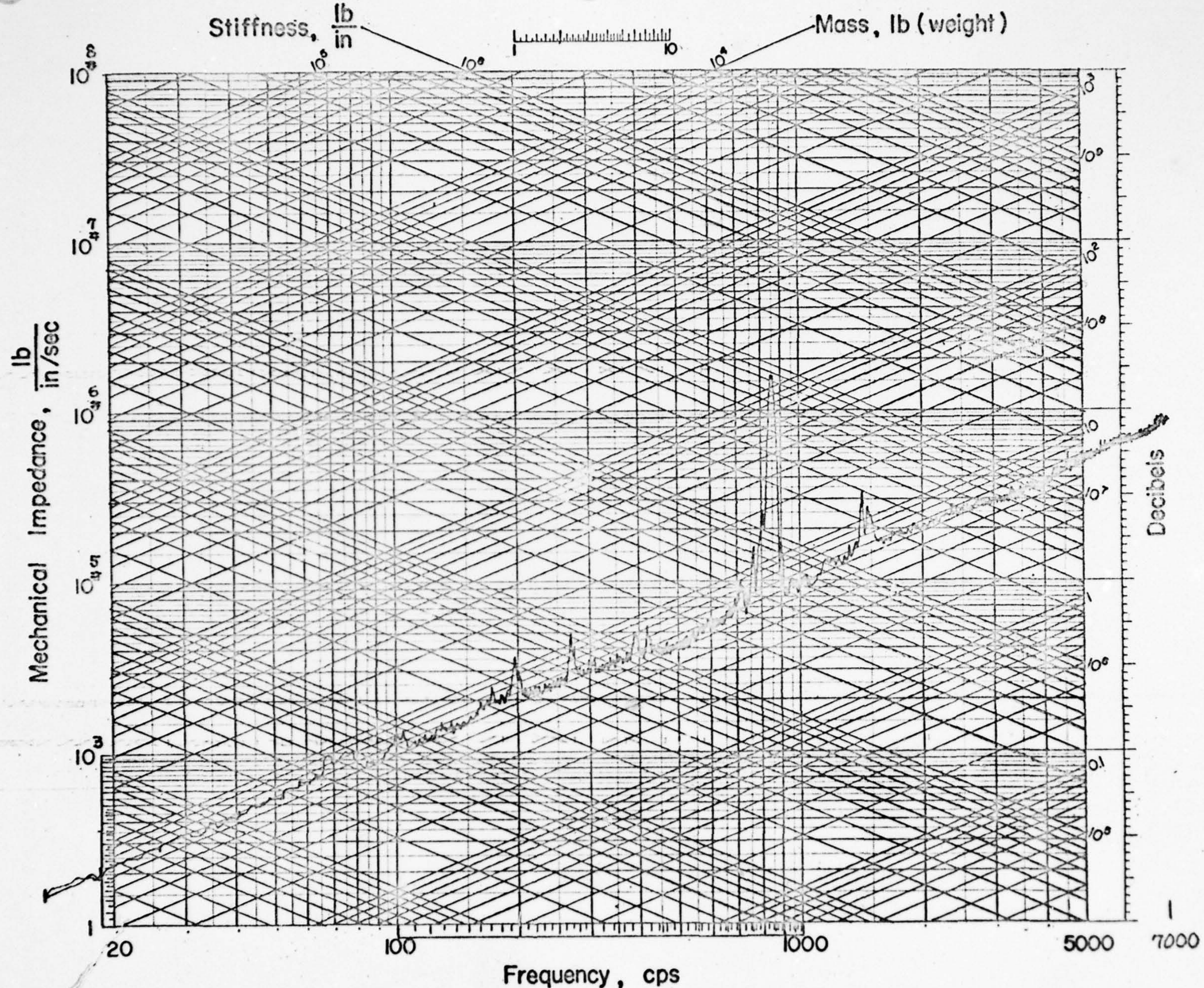
POSN. 3 IN WATER WITH TRANSDUCER

FIG. 14



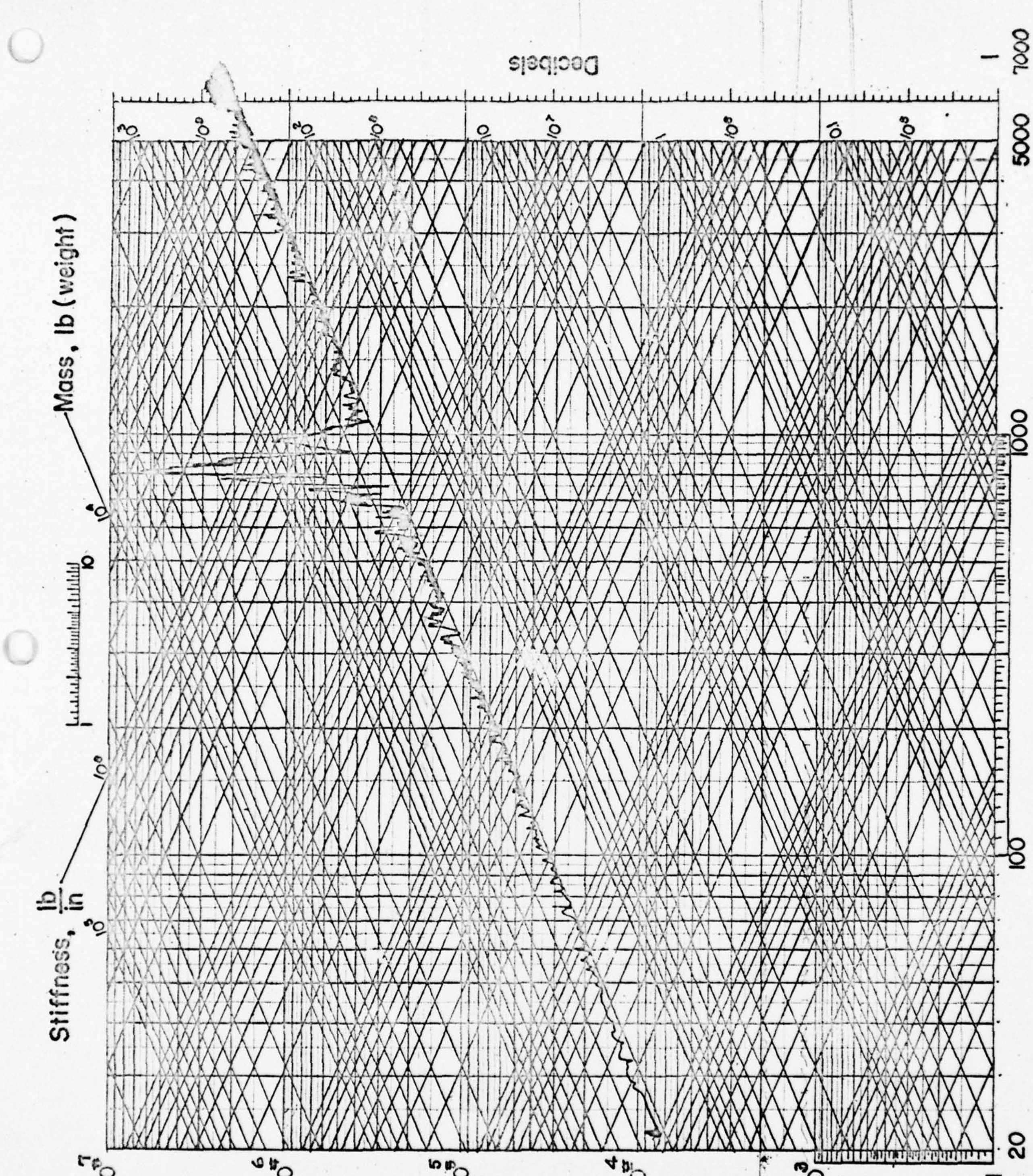
POSN. 4 IN AIR WITH TRANSDUCER

FIG. 15



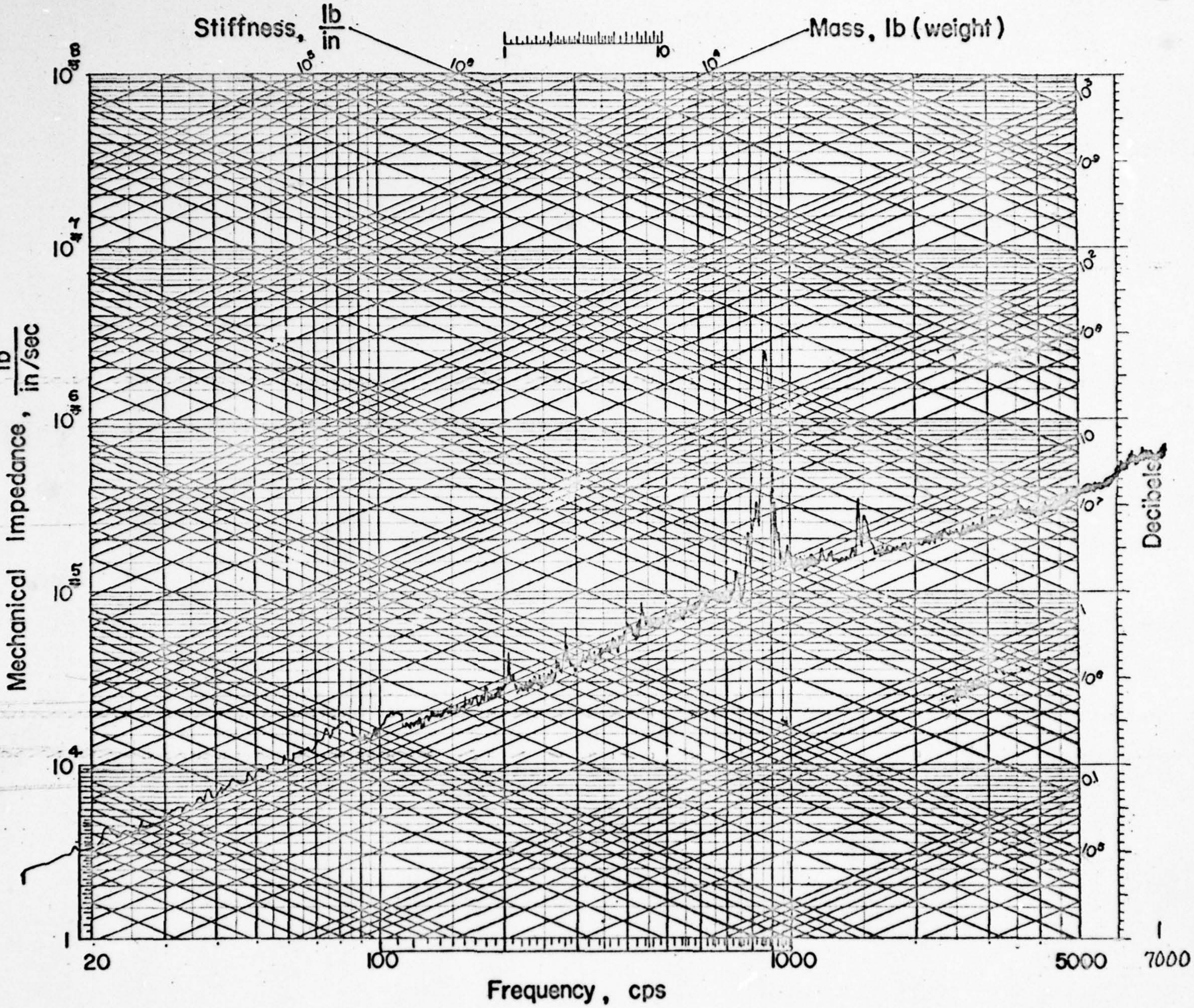
POSN. 4 IN WATER WITH TRANSDUCER

FIG. 16



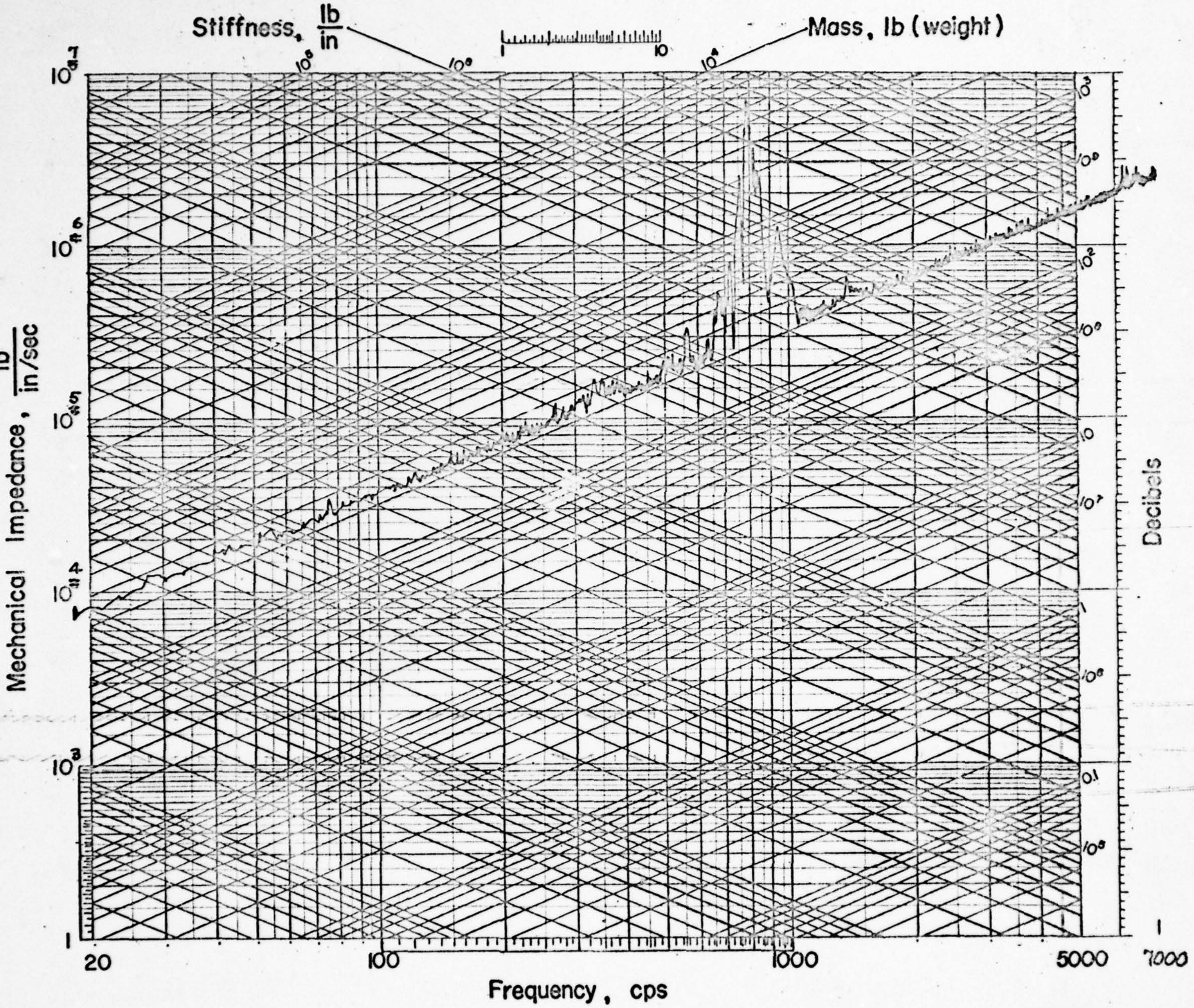
POSN. 5 IN AIR WITH TRANSDUCER

FIG. 17



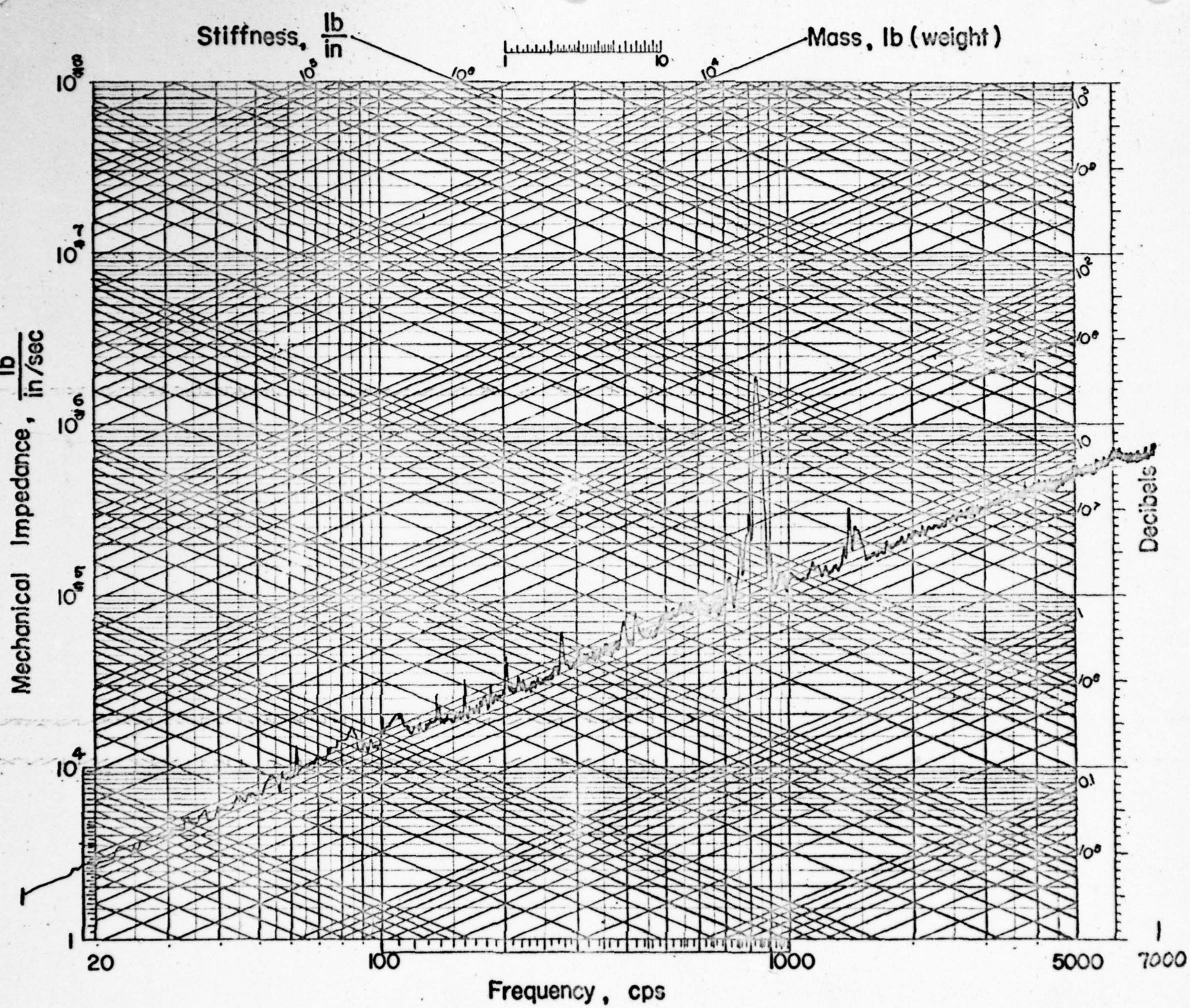
POSN. 5 IN WATER WITH TRANSDUCER

FIG. 18



POSN. 6 IN AIR WITH TRANSDUCER

FIG. 19



POSN. 6 IN WATER WITH TRANSDUCER

FIG. 20

POSITION 1 NOSE F/A

DOME CONDITIONS

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR NO TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER NO TRANSDUCER DECAY RATE (DB*/SEC)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
200	48	210	56	173	185	22
250	56	221	42	320	190	61
315	58	380	53	362	152	91
400	58	433	61	368	216	466
500	103	580	64	305	275	456
625	220	513	85	250	355	205
800	230	650	110	330	352	163
1000	207	625	100	368	368	94
1250	163	500	94	375	333	137
1600	218	810	106	513	218	200
2000	274	825	122	605	293	390
2500	304	780	170	863	207	345
3150	312	894	163	813	242	562
4000	300	1730	137	950	183	513
5000	330	2330	187	1270	187	738
6250	425	2450	165	1500	200	1450
8000	605	2800	133	1690	207	1560

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE VS THIRD OCTAVE BAND CENTER FREQUENCY

* 0 DB re: 1 μ BAR

FIG. 21

POSITION 2 CHIN NORMAL

DOME CONDITIONS

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR NO TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER NO TRANSDUCER DECAY RATE (DB*/SEC)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
200	42	94	50	173	350	157
250	48	84	45	138	173	432
315	64	165	57	173	204	224
400	76	169	54	232	153	241
500	125	350	69	368	173	268
625	144	268	71	305	275	250
800	190	242	100	270	280	308
1000	135	190	94	332	238	282
1250	137	250	106	268	262	180
1600	180	354	112	317	305	255
2000	225	561	82	332	293	280
2500	230	645	116	275	200	342
3150	208	687	154	325	137	450
4000	270	675	180	417	167	500
5000	250	625	175	487	192	1100
6250	220	437	215	281	165	1440
8000	225	231	200	375	200	1690

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE VS THIRD OCTAVE BAND CENTER FREQUENCY

* 0 DB re: 1 μ BAR

FIG. 22

POSITION 3 SIDE P/S

DOME CONDITIONS

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR NO TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER NO TRANSDUCER DECAY RATE (DB*/SEC)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
200	37	92	76	117	122	490
250	60	164	64	137	166	468
315	60	250	50	275	94	575
400	70	382	57	362	140	527
500	122	380	94	435	159	262
625	187	380	109	425	167	242
800	230	375	100	469	215	175
1000	187	425	117	530	180	195
1250	177	325	110	394	200	280
1600	200	675	125	530	280	363
2000	242	668	165	675	325	400
2500	353	800	168	670	270	450
3150	270	680	150	665	355	450
4000	300	906	156	688	242	605
5000	542	725	210	750	200	935
6250	675	836	250	1180	331	750
8000	605	442	183	1500	344	610

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE VS THIRD OCTAVE BAND CENTER FREQUENCY

* 0 DB re: 1 μ BAR

FIG. 23

POSITION 4 BTM RING V

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
	DOME CONDITIONS			
200	72	70	146	177
250	58	119	173	200
315	72	117	88	475
400	52	206	167	356
500	56	318	232	350
625	112	380	180	562
800	120	437	305	582
1000	170	338	125	1075
1250	107	500	105	1210
1600	75	356	85	1940
2000	87	430	155	1810
2500	77	356	170	1440
3150	80	325	120	1690
4000	82	395	107	2370
5000	110	450	167	2010
6250	127	763	182	1830
8000	128	815	185	1610

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE VS THIRD OCTAVE BAND CENTER FREQ.

* 0 DB re: 1 μ BAR

FIG. 24

POSITION 5 BTM RING P/S

DOME CONDITIONS

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
200	75	54	45	224
250	52	98	52	418
315	64	119	102	600
400	75	94	104	687
500	100	105	208	940
625	120	108	250	1620
800	106	250	318	1920
1000	100	206	250	1690
1250	129	230	450	2190
1600	112	235	312	1790
2000	100	243	218	1500
2500	97	292	212	1520
3150	84	235	156	1610
4000	160	310	106	1170
5000	148	330	144	1660
6250	187	345	175	1370
8000	155	275	137	1650

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE VS THIRD OCTAVE BAND CENTER FREQ.

* 0 DB re: 1 μ BAR

FIG. 25

POSITION 6 BTM RING F/A

DOME CONDITIONS

THIRD OCTAVE BAND CENTER FREQ (CPS)	IN AIR WITH TRANSDUCER DECAY RATE (DB*/SEC)	IN WATER WITH TRANSDUCER DECAY RATE (DB*/SEC)	ON SHIP IN AIR DECAY RATE (DB*/SEC)	ON SHIP IN WATER DECAY RATE (DB*/SEC)
200	32	97	100	340
250	42	83	86	417
315	46	100	230	675
400	52	127	232	575
500	56	203	187	927
625	61	295	145	1330
800	96	405	275	1820
1000	106	370	450	2000
1250	94	282	550	2060
1600	105	394	562	1650
2000	119	462	180	2150
2500	132	544	157	1730
3150	207	875	112	1608
4000	145	1250	130	1370
5000	167	1440	150	1680
6250	190	1750	157	1610
8000	170	2120	182	1650

U.S.S. WITEK (EDD 848)

SONAR DOME DECAY RATE SUMMARY

DECAY RATE vs THIRD OCTAVE BAND CENTER FREQ.

* 0 DB re: 1 μ BAR

FIG. 26

USN-USL-851(Rev. 1/60)

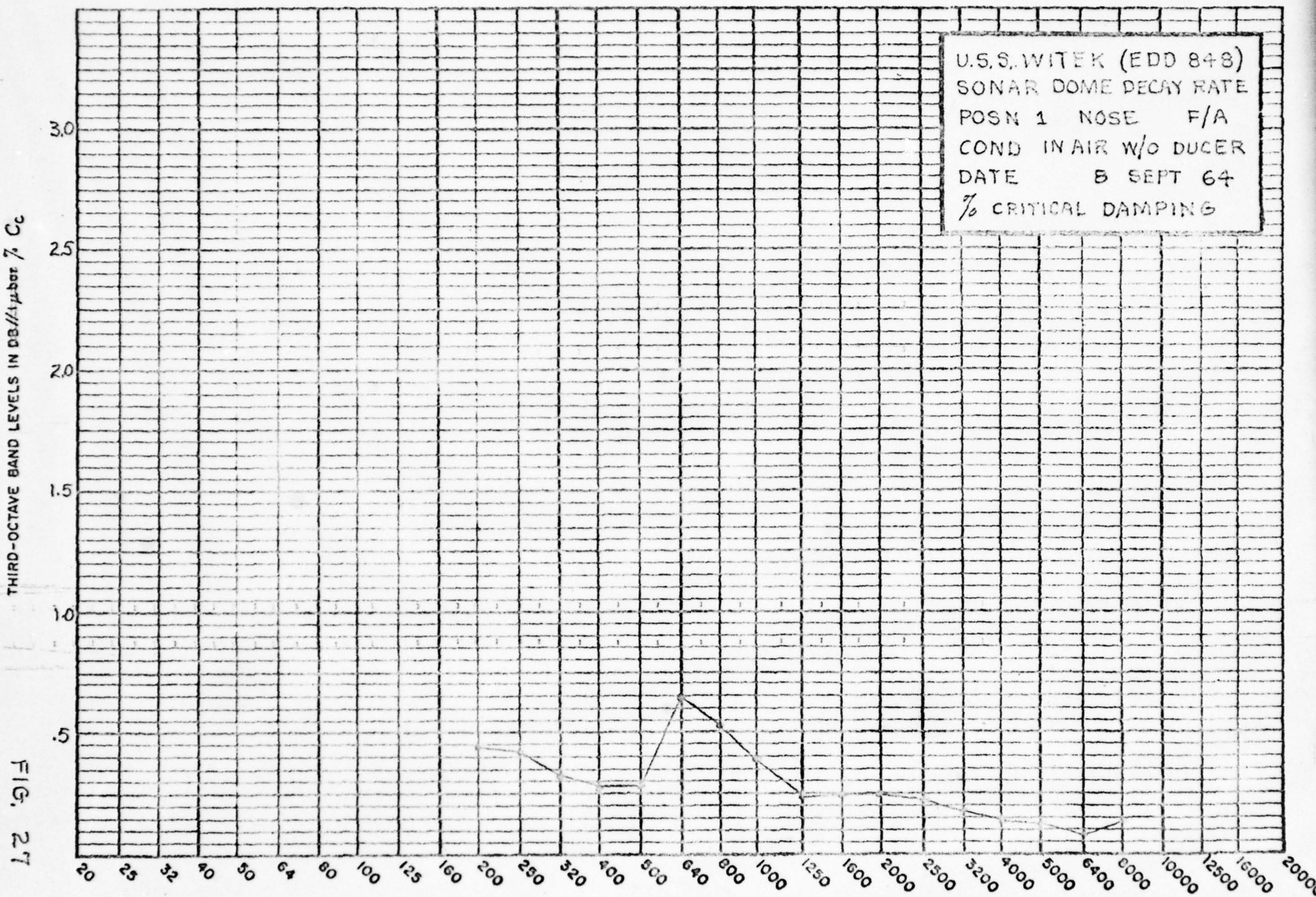


FIG. 27

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651(Rev. 1/60)

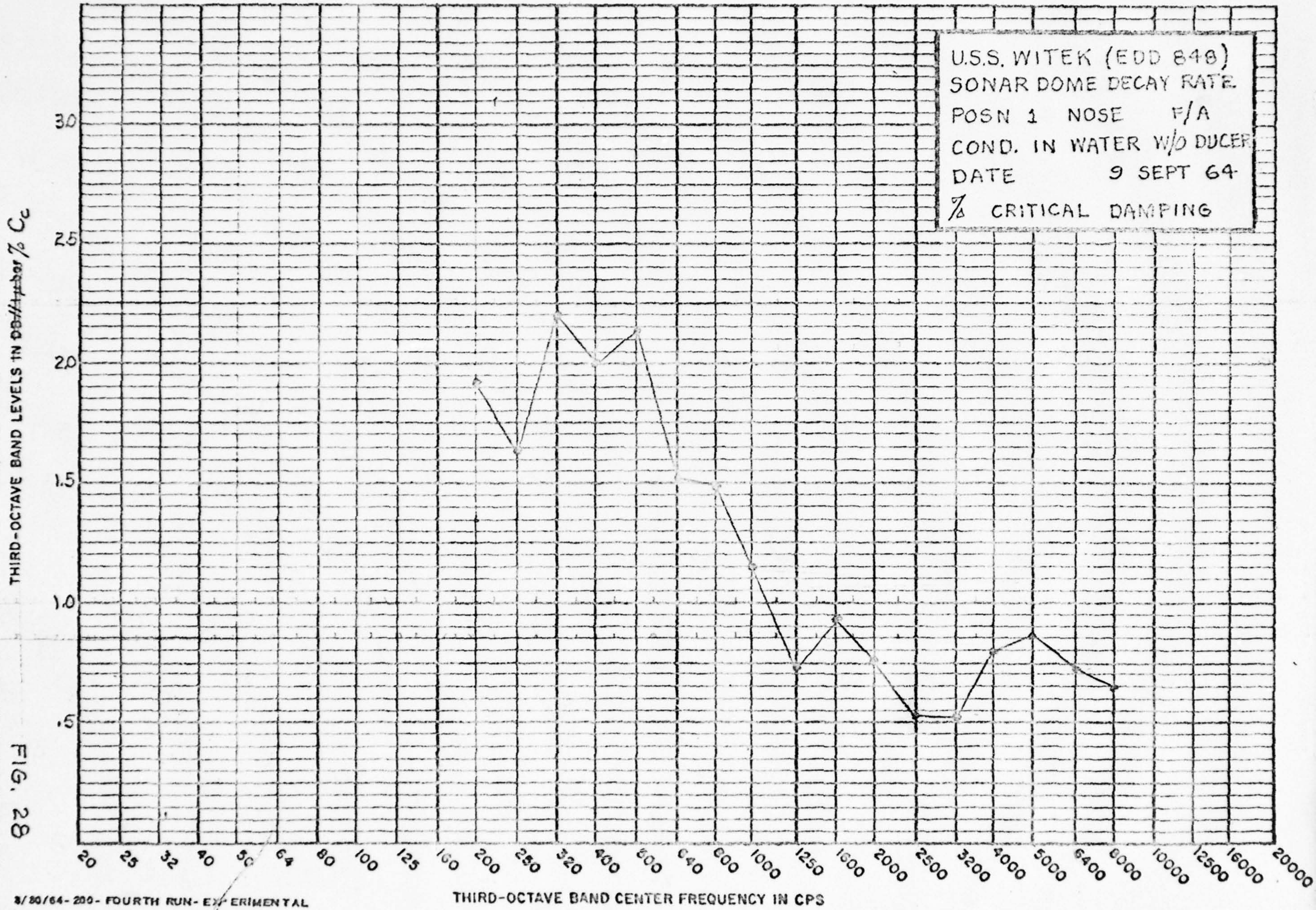


FIG. 28

3/30/64- 200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

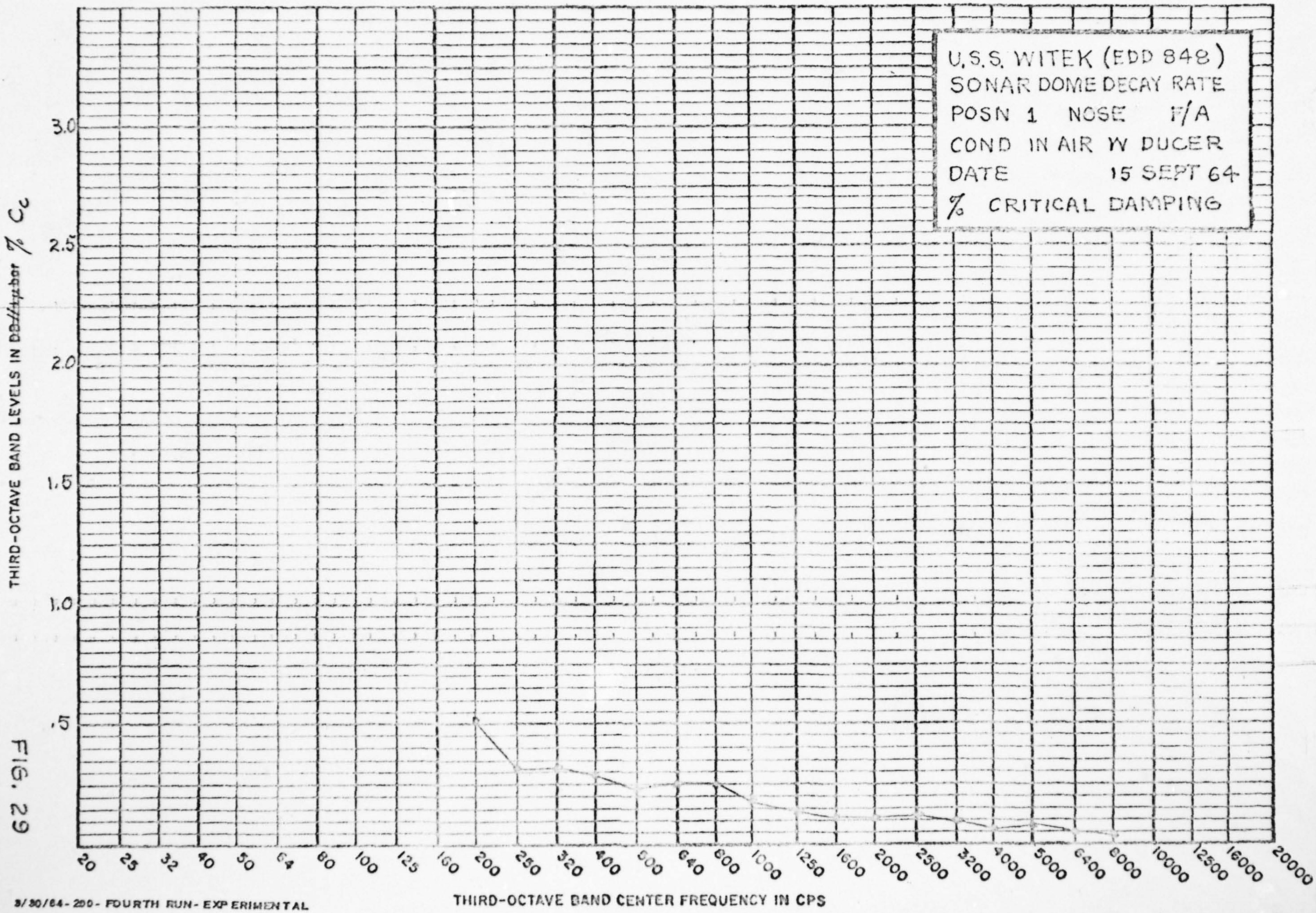


FIG. 29

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651 (Rev. 1/60)

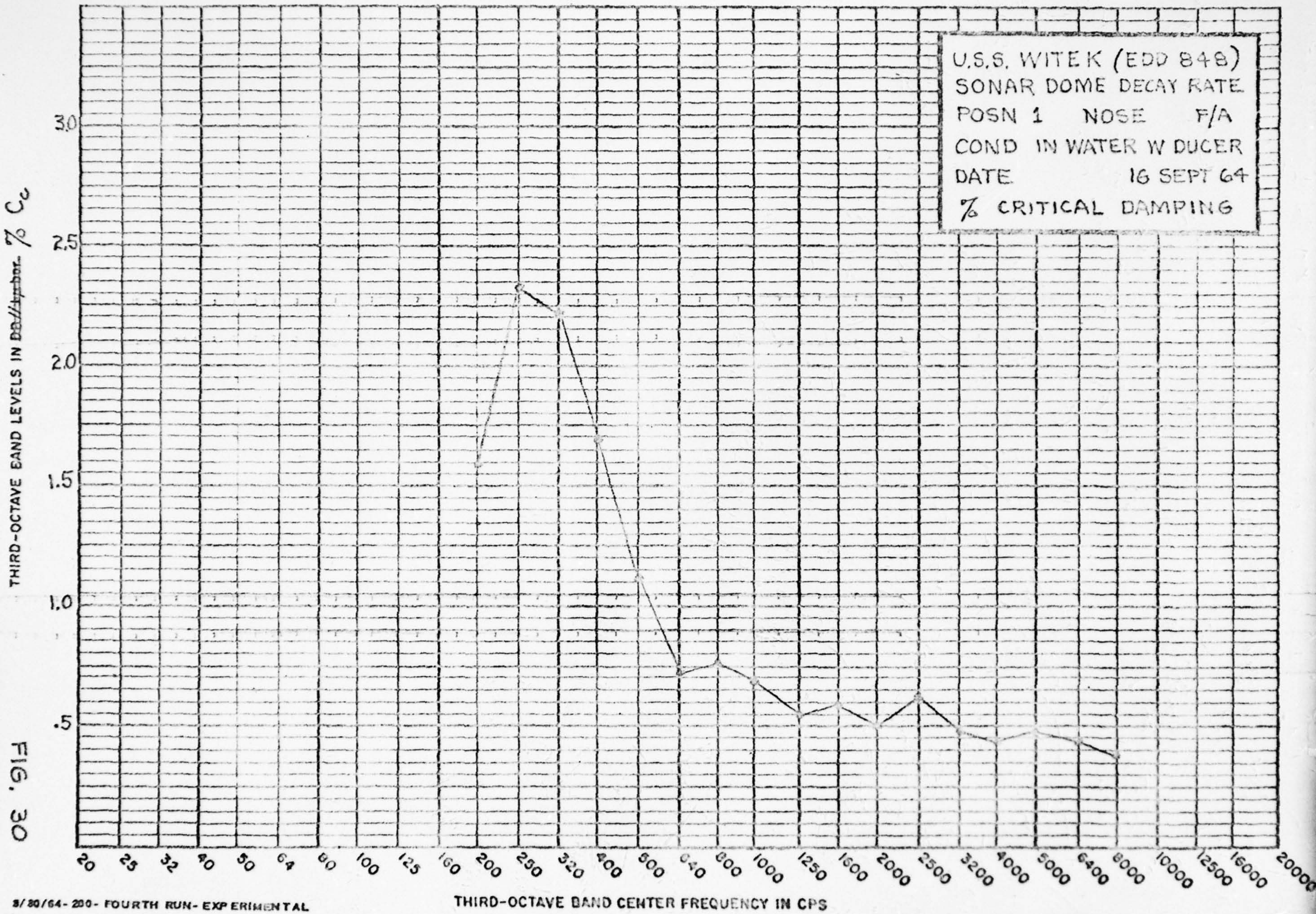


FIG. 30

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

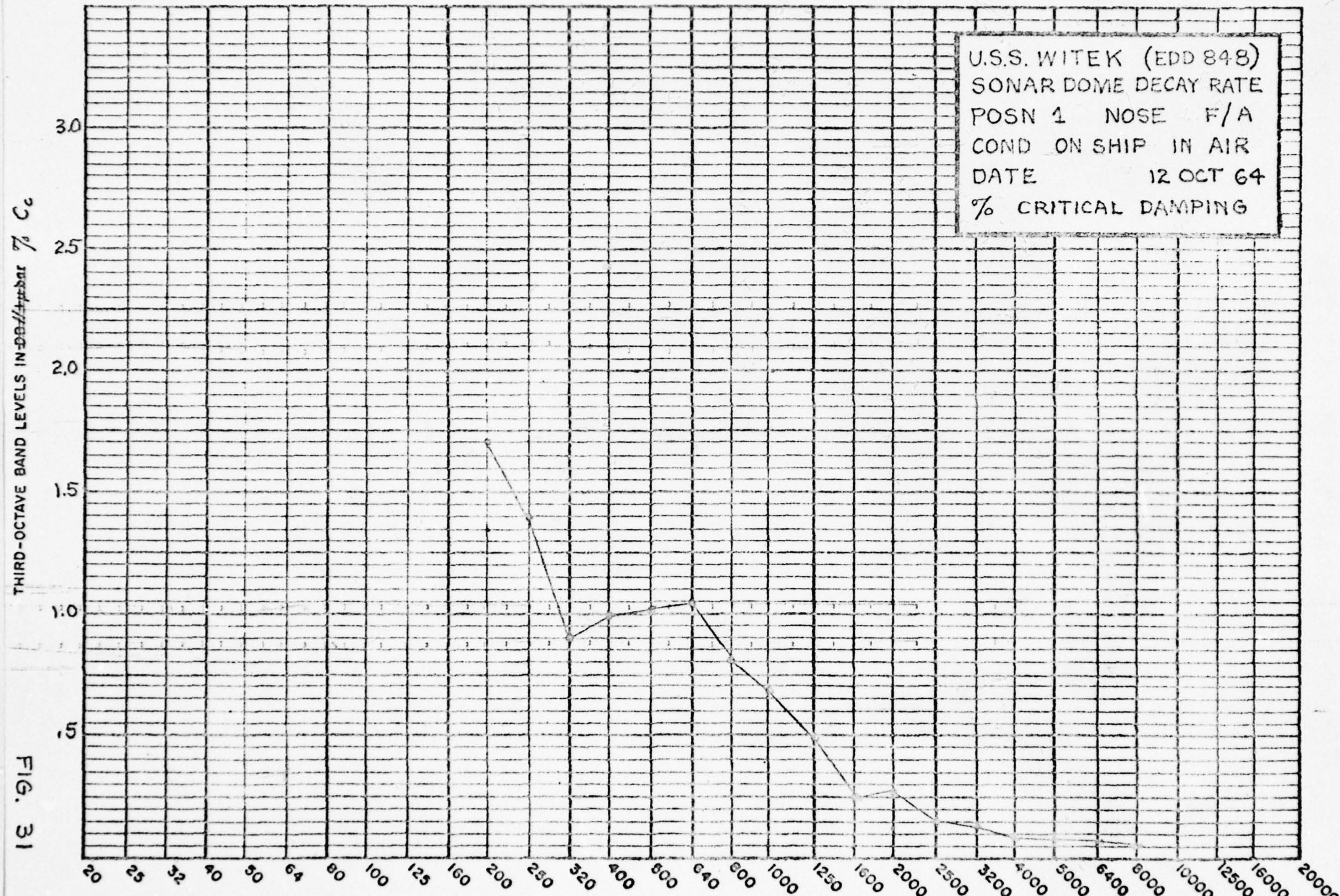


FIG. 31

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

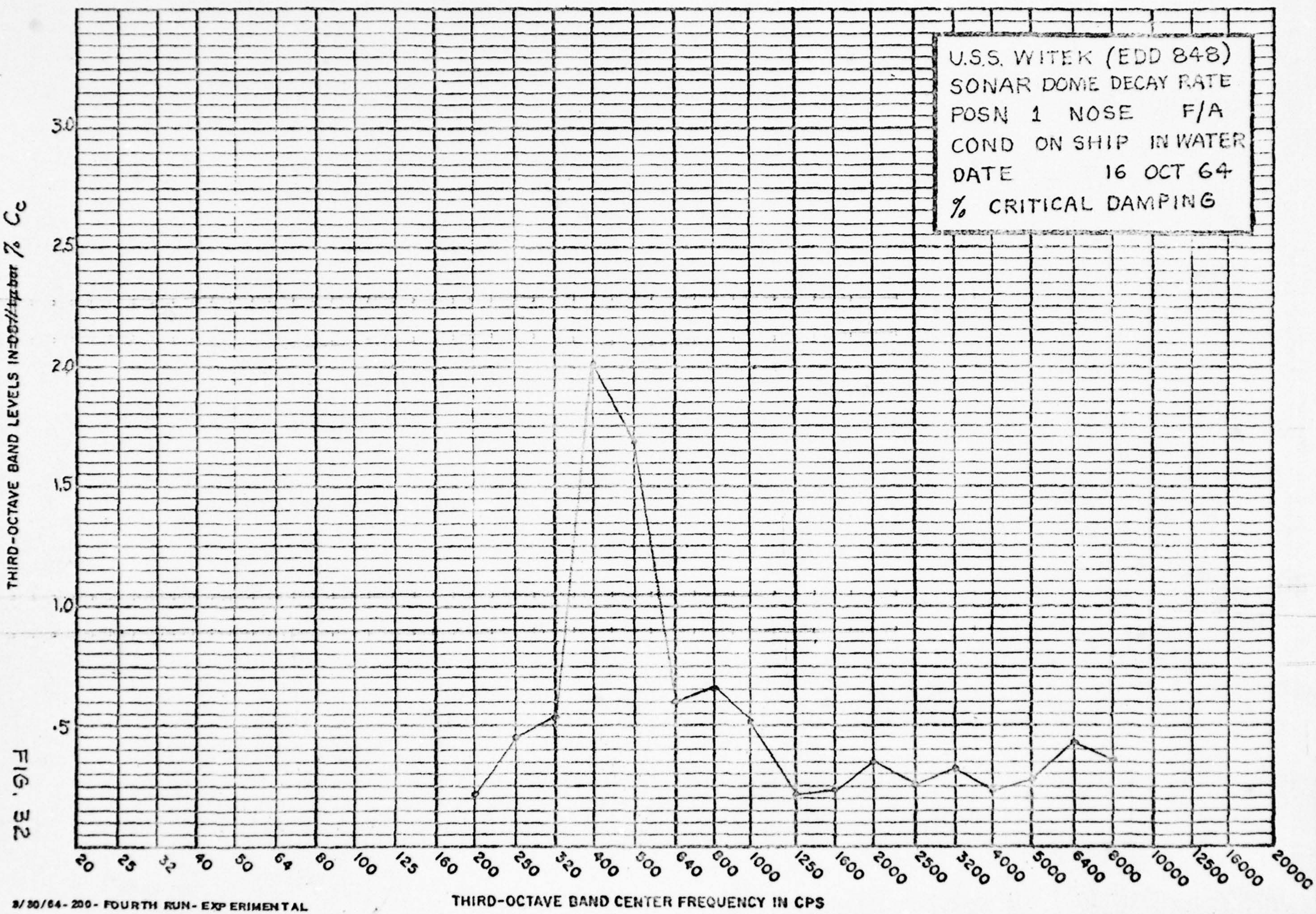


FIG. 32

9/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

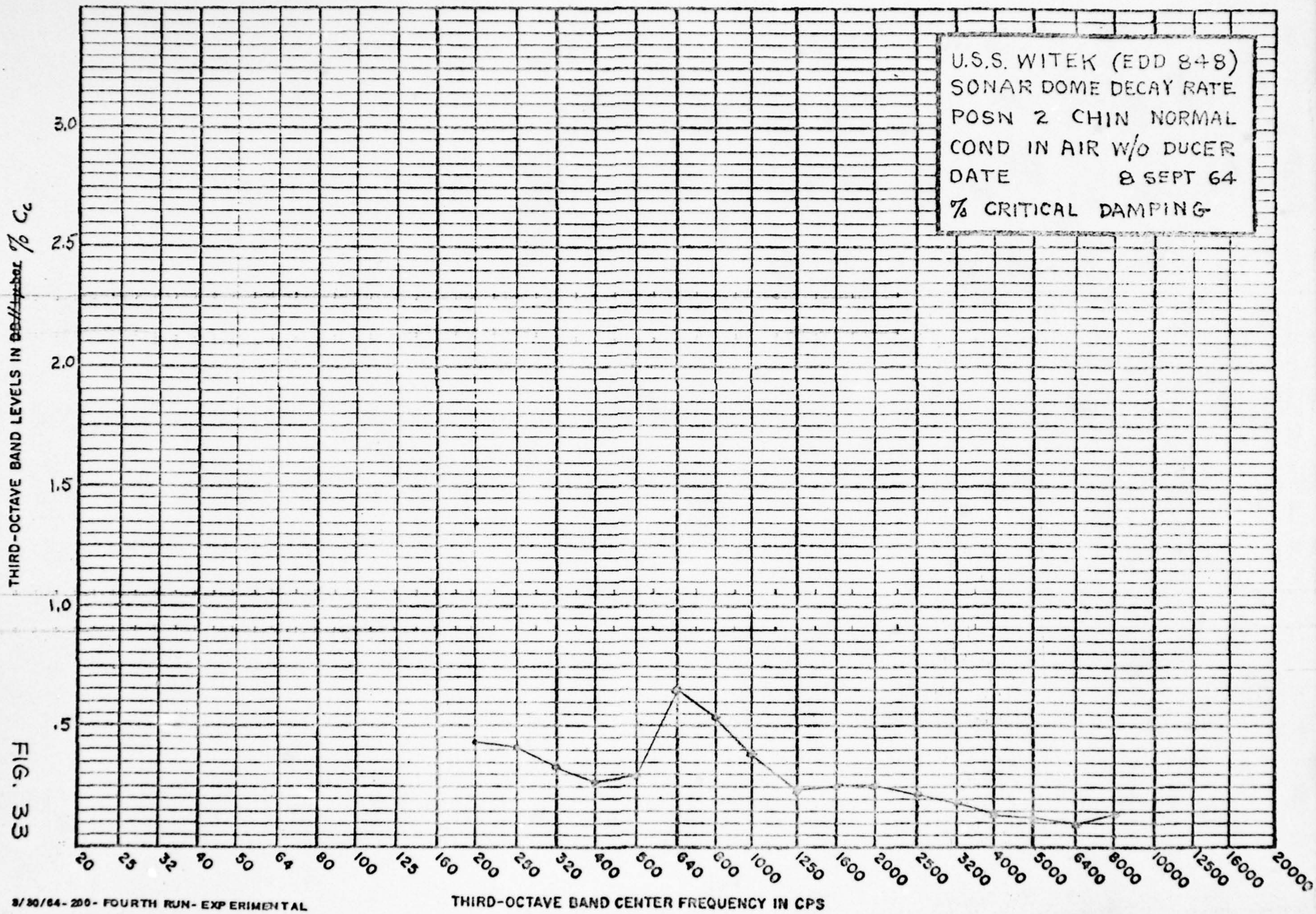


FIG. 33

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651(Rev. 1/60)

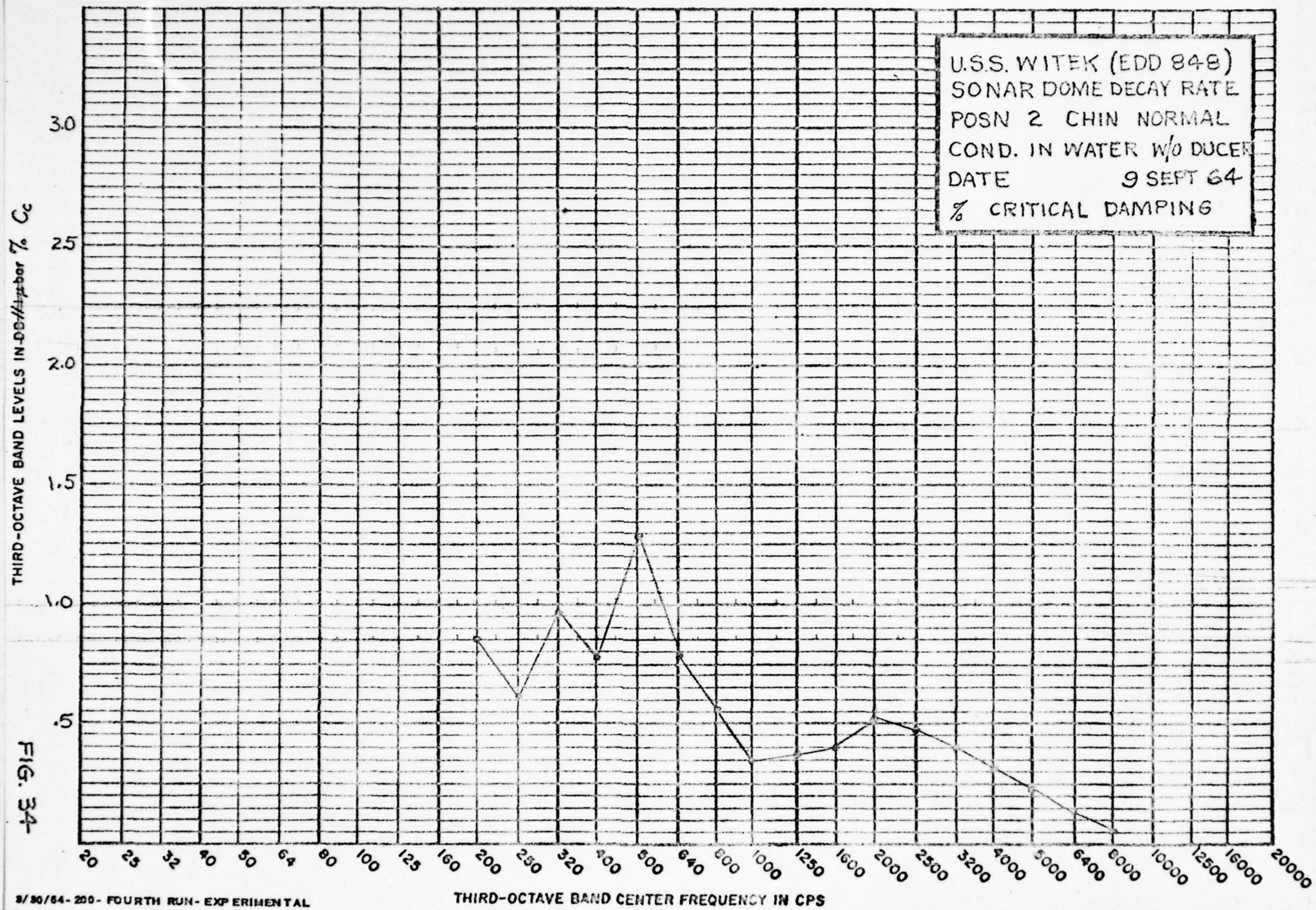


FIG. 34

9/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/80)

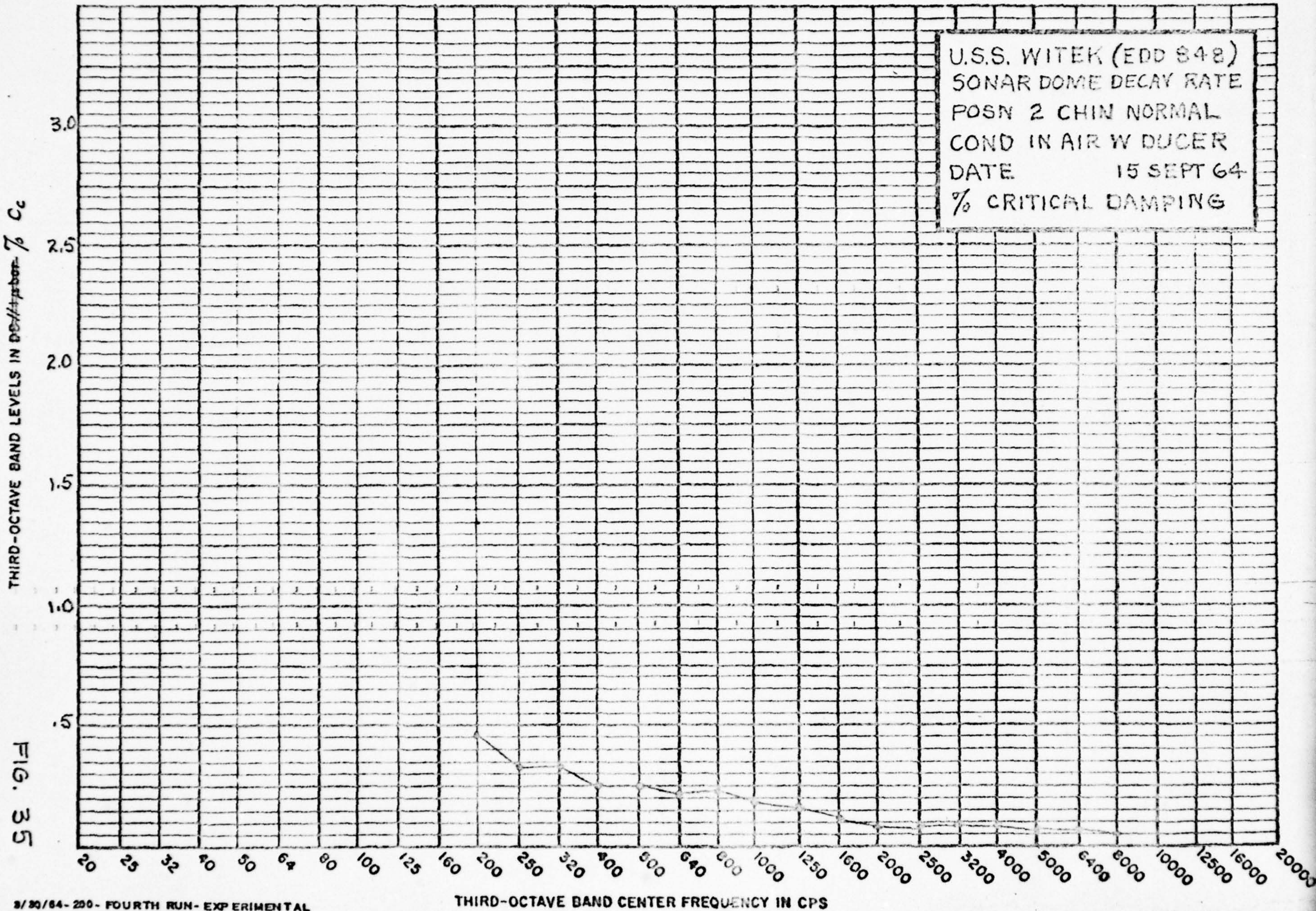


FIG. 35

3/30/64- 200- FOURTH RUN- EXPERIMENTAL

USN-USL-851 (Rev. 1/60)

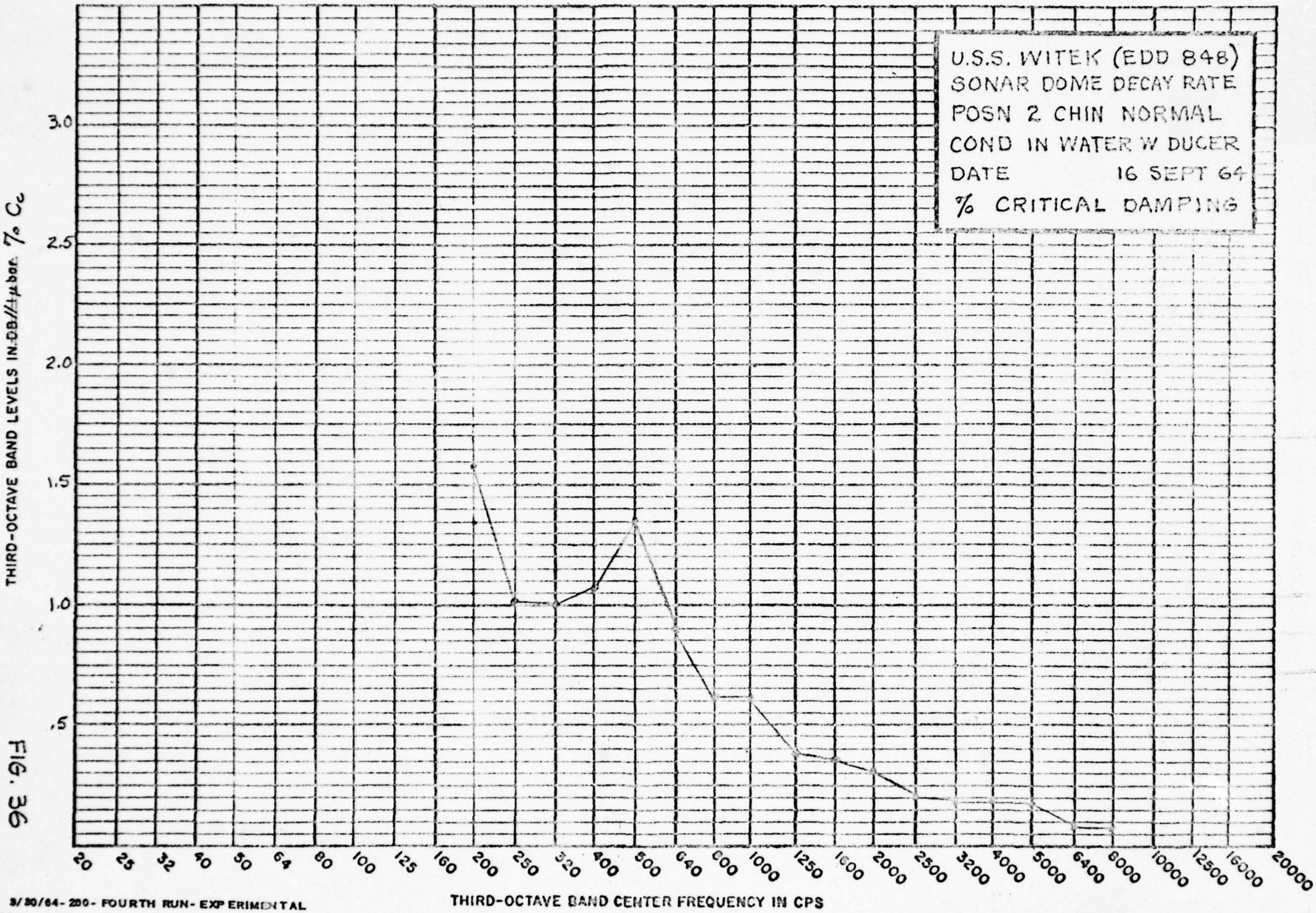


FIG. 36

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

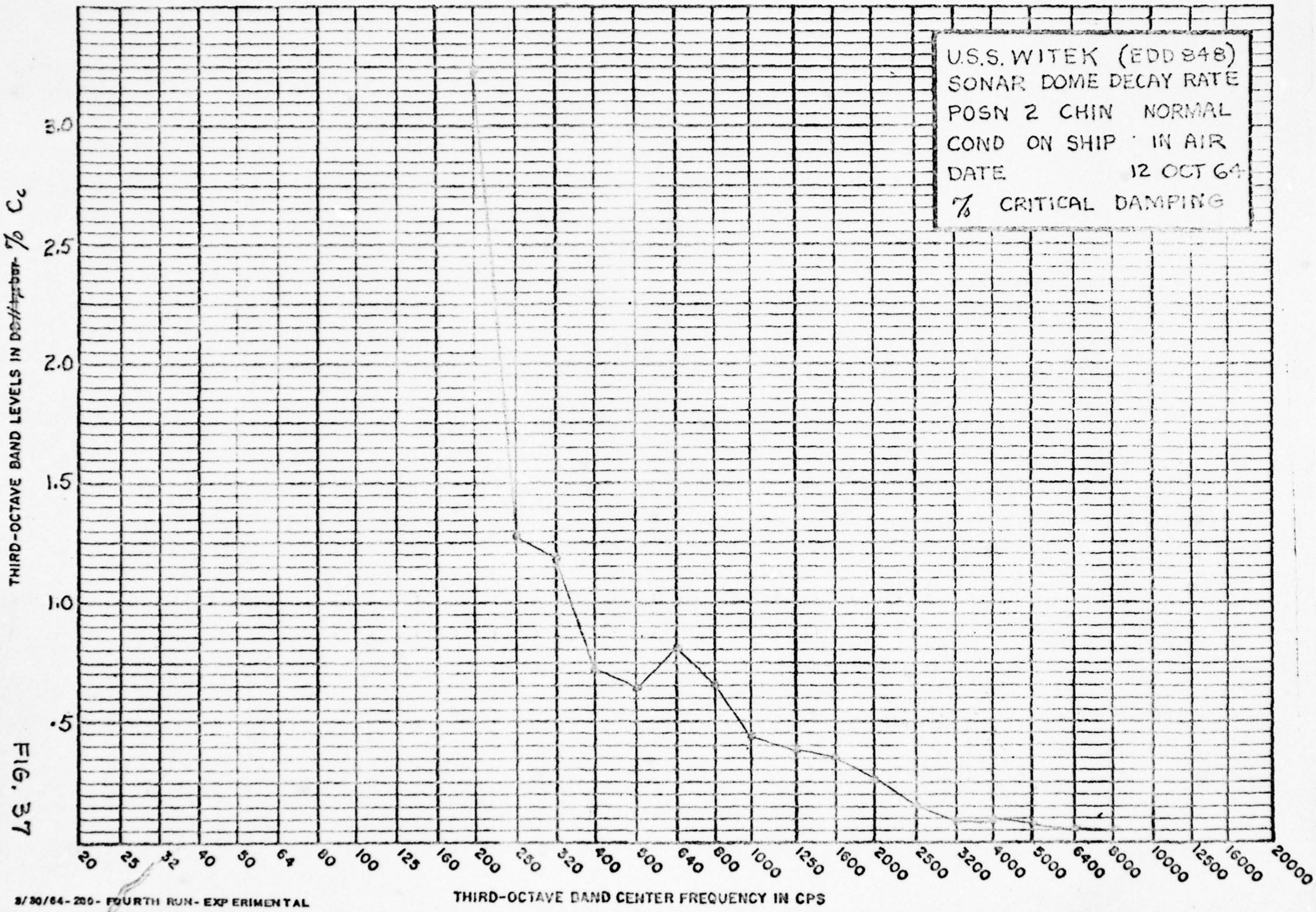


FIG. 37

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

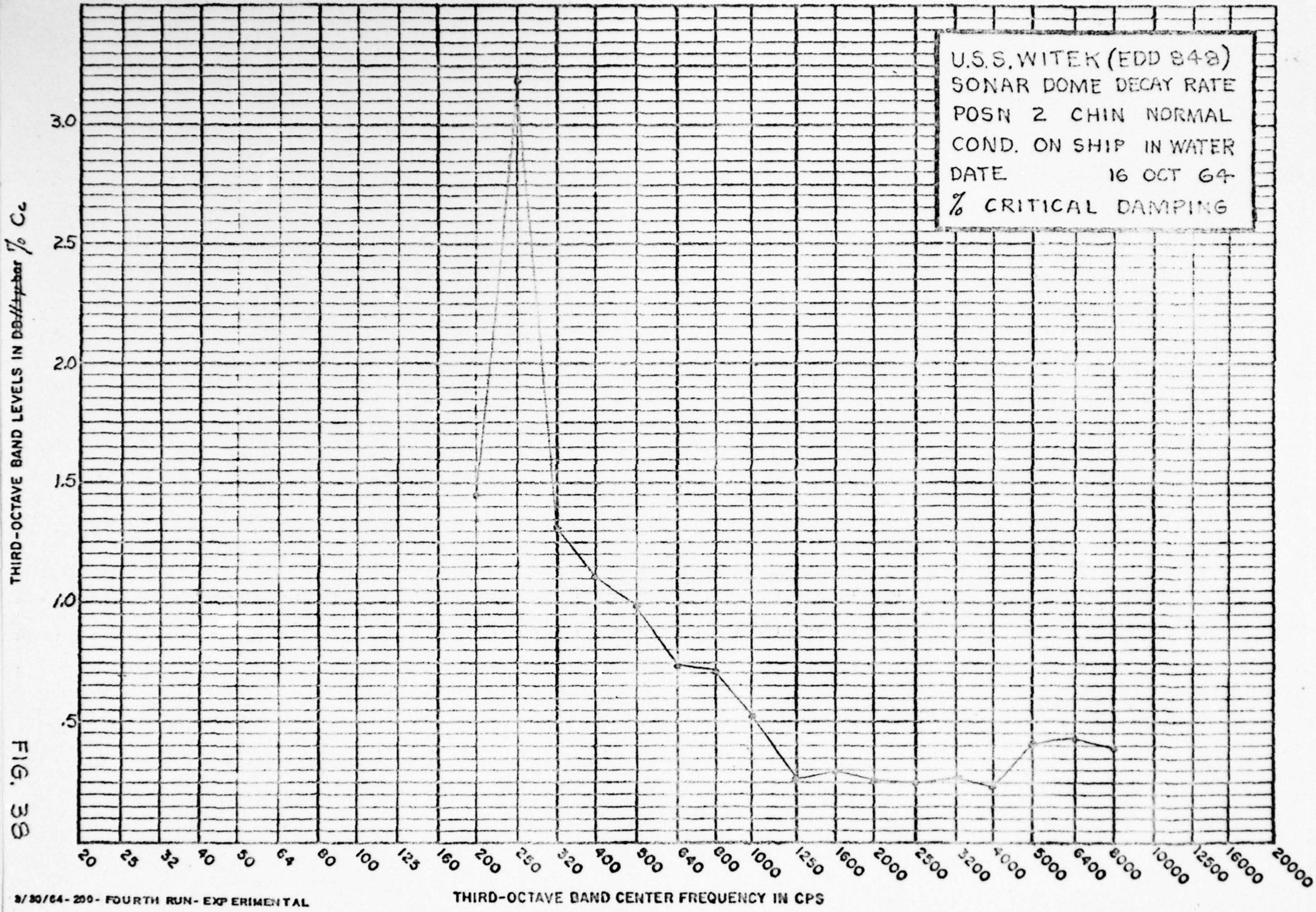


FIG. 38

9/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851 (Rev. 1/60)

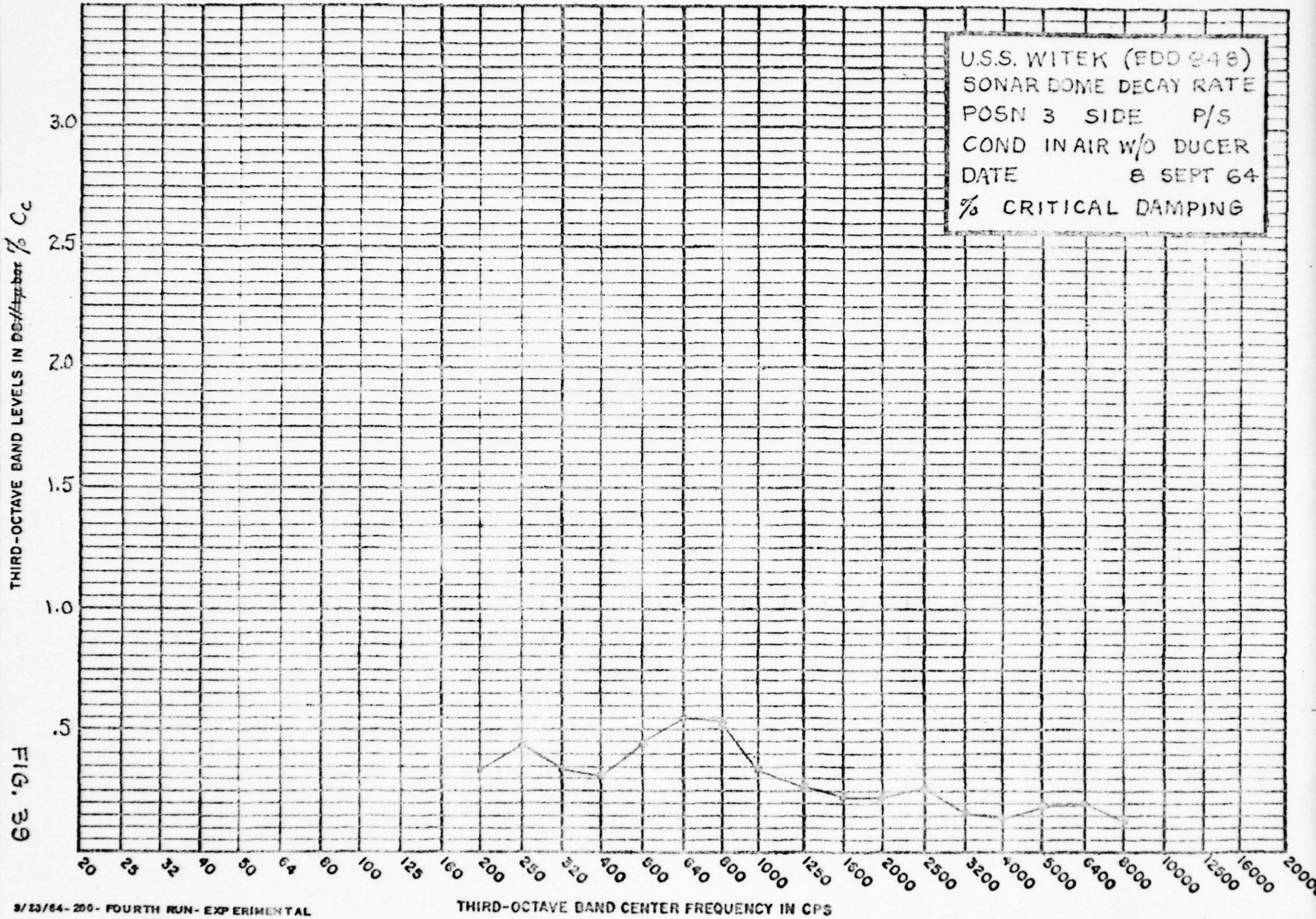


FIG. 39

8/23/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

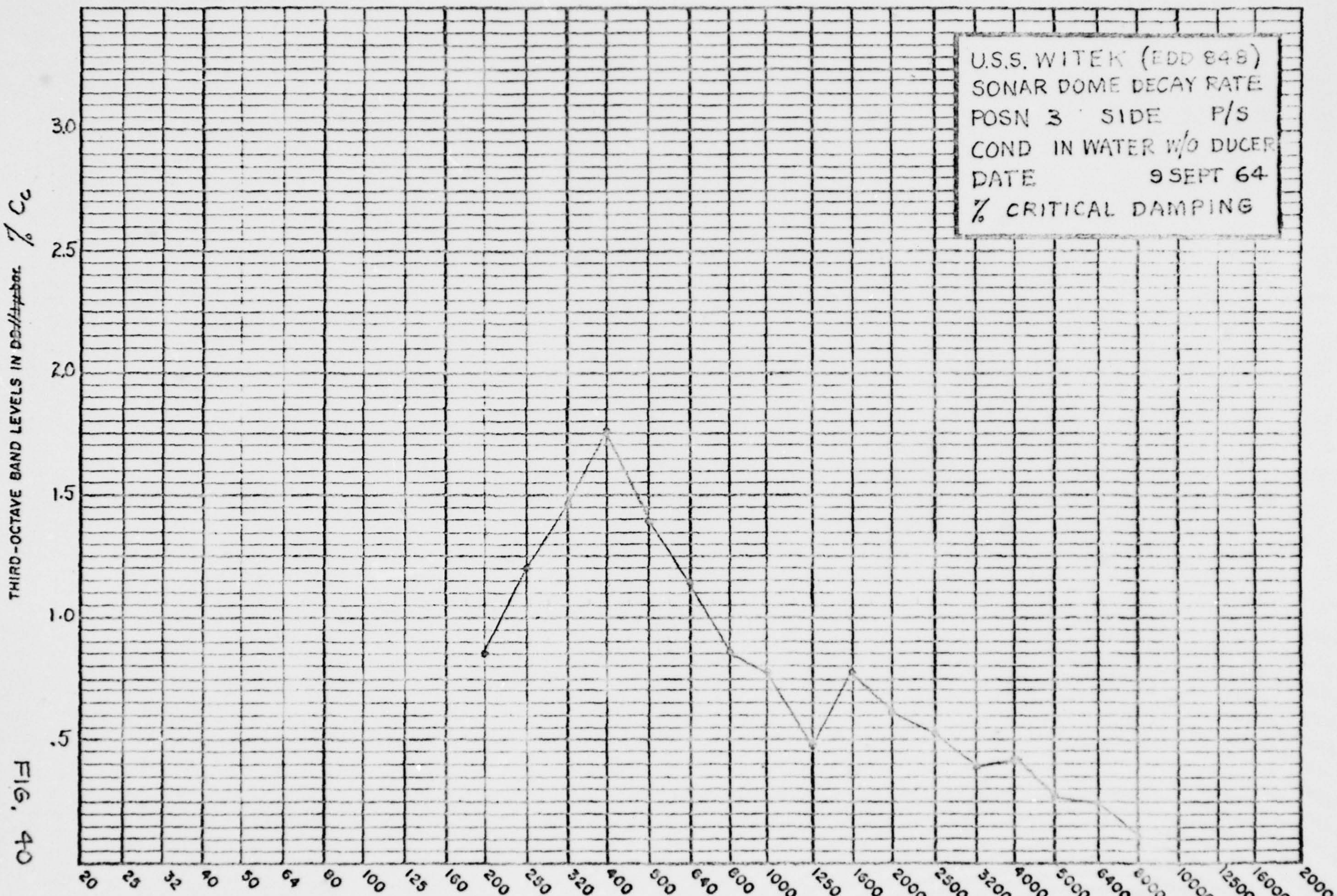


FIG. 40

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

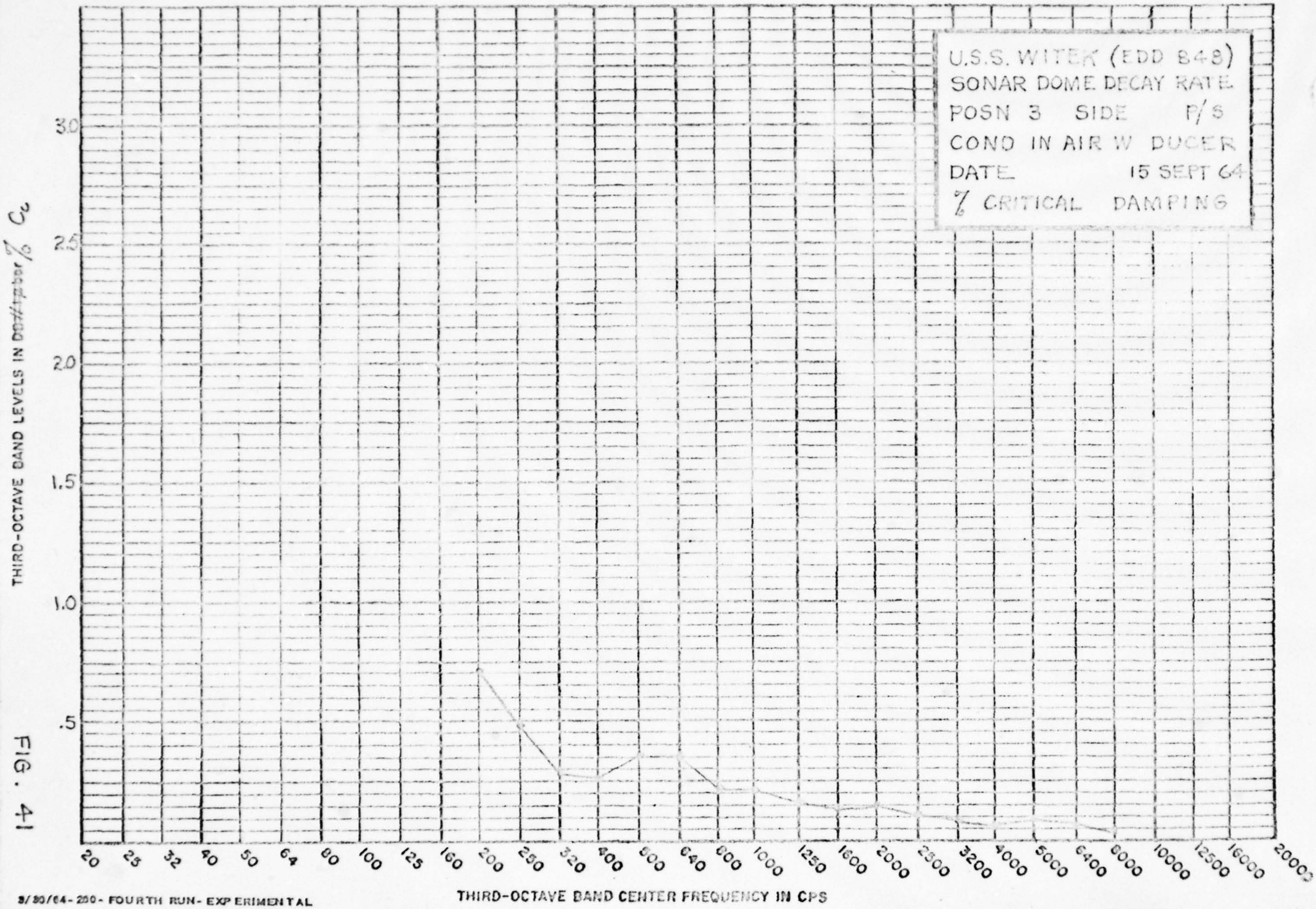


FIG. 41

3/30/64-250- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

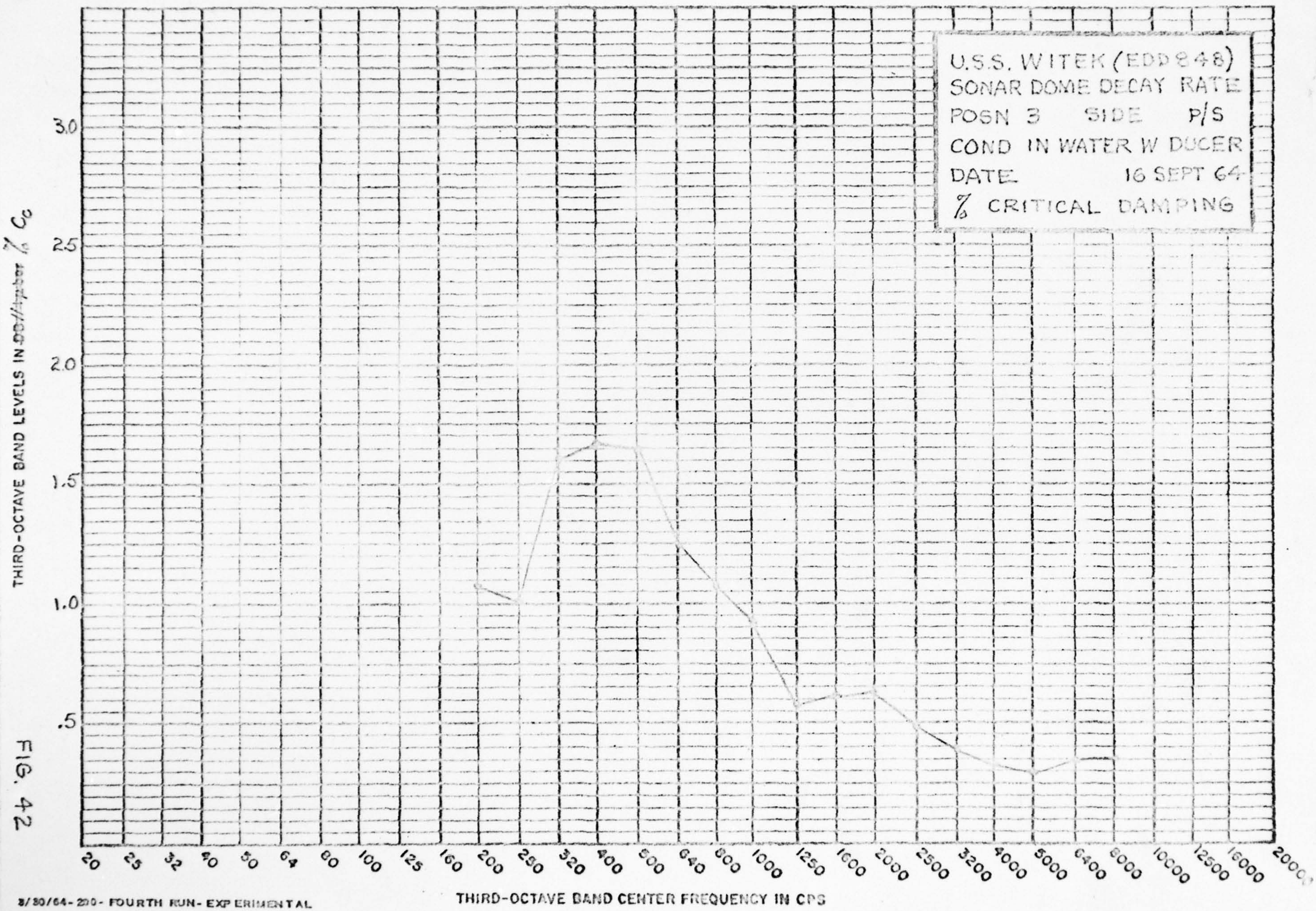


FIG. 42

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851 (Rev. 1/60)

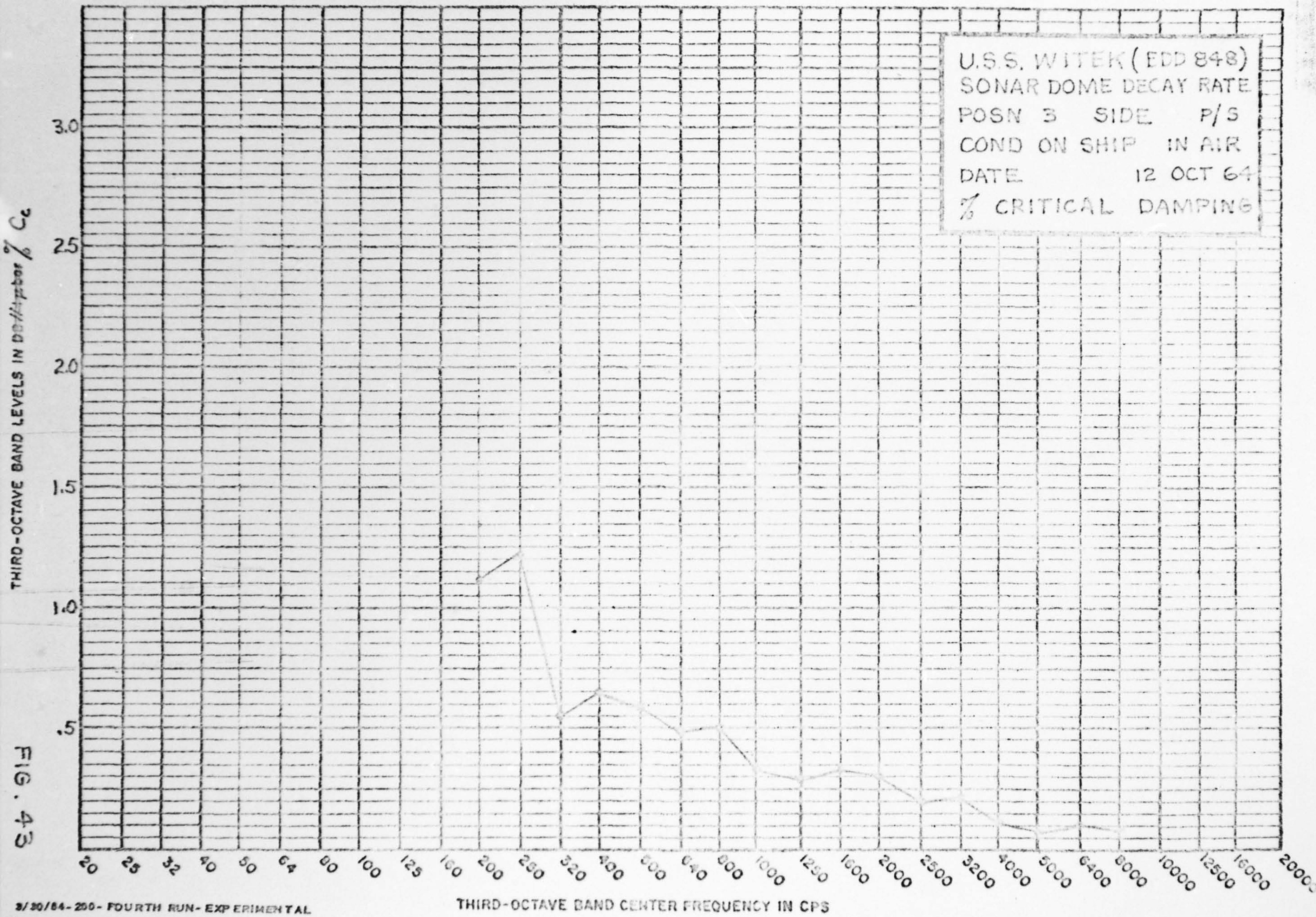


FIG. 43

3/30/64-200- FOURTH RUN- EXPERIMENTAL

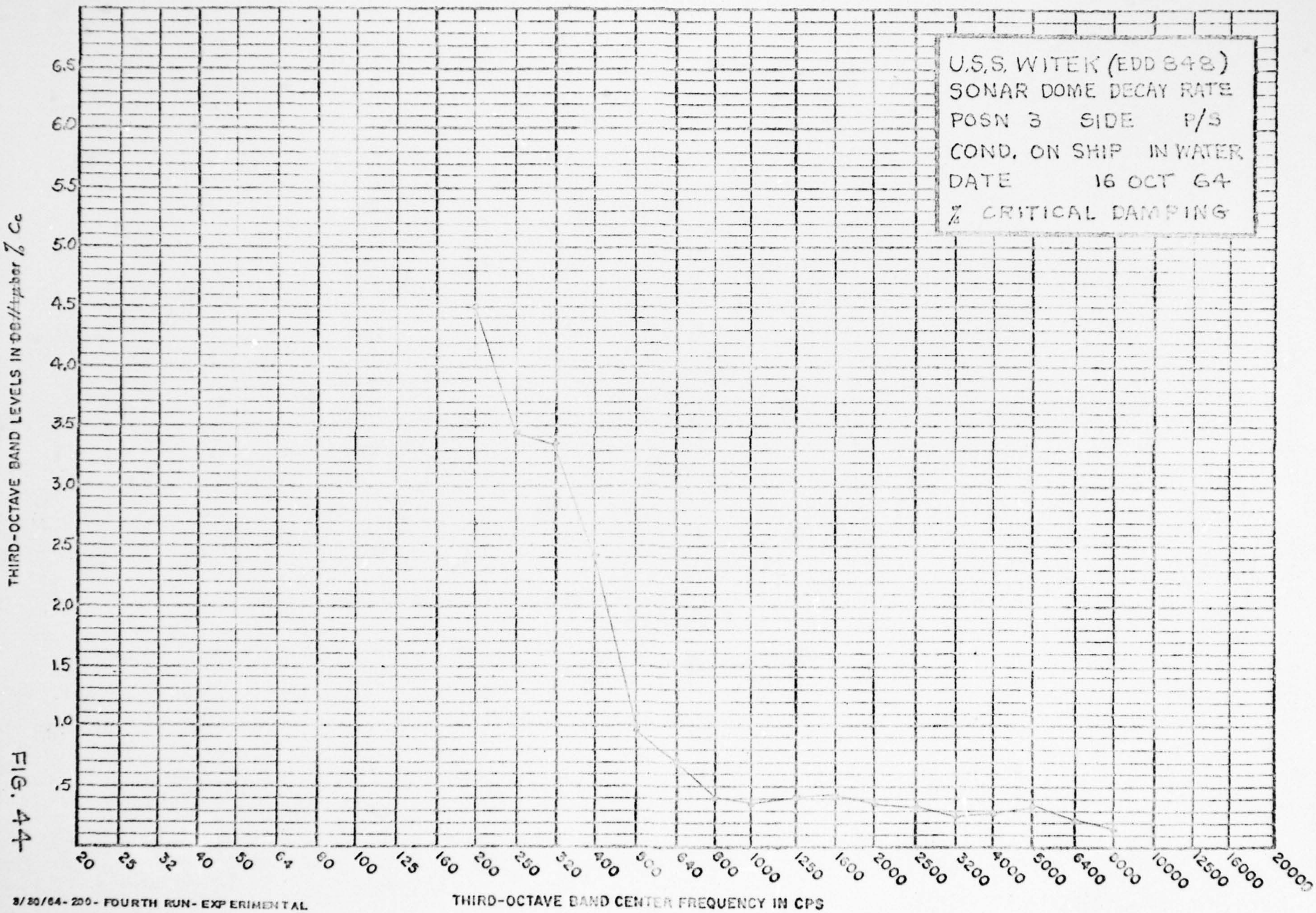

U.S.S. WITEK (EDD 848)
SONAR DOME DECAY RATE
POSN 3 SIDE P/S
COND. ON SHIP IN WATER
DATE 16 OCT 64
% CRITICAL DAMPING
THIRD-OCTAVE BAND LEVELS IN ~~DB//Μbar~~ % Cc
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
.5
20 25 32 40 50 64 80 100 125 160 200 250 320 400 500 640 800 1000 1250 1600 2000 2500 3200 4000 5000 6400 8000 10000 12500 16000 20000
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIG. 44

USN-USL-851(Rev. 1/60)

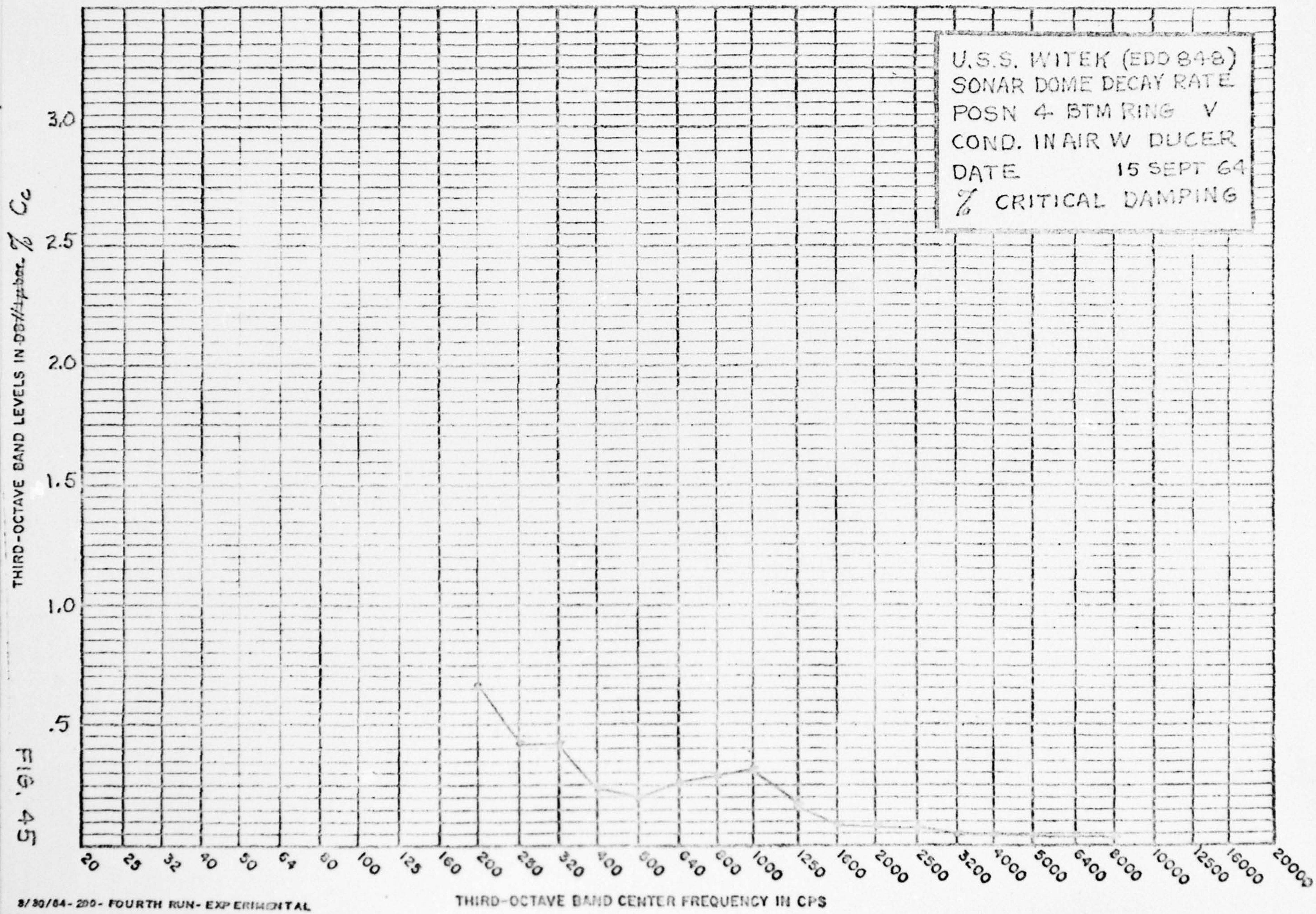


FIG. 45

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851 (Rev. 1/60)

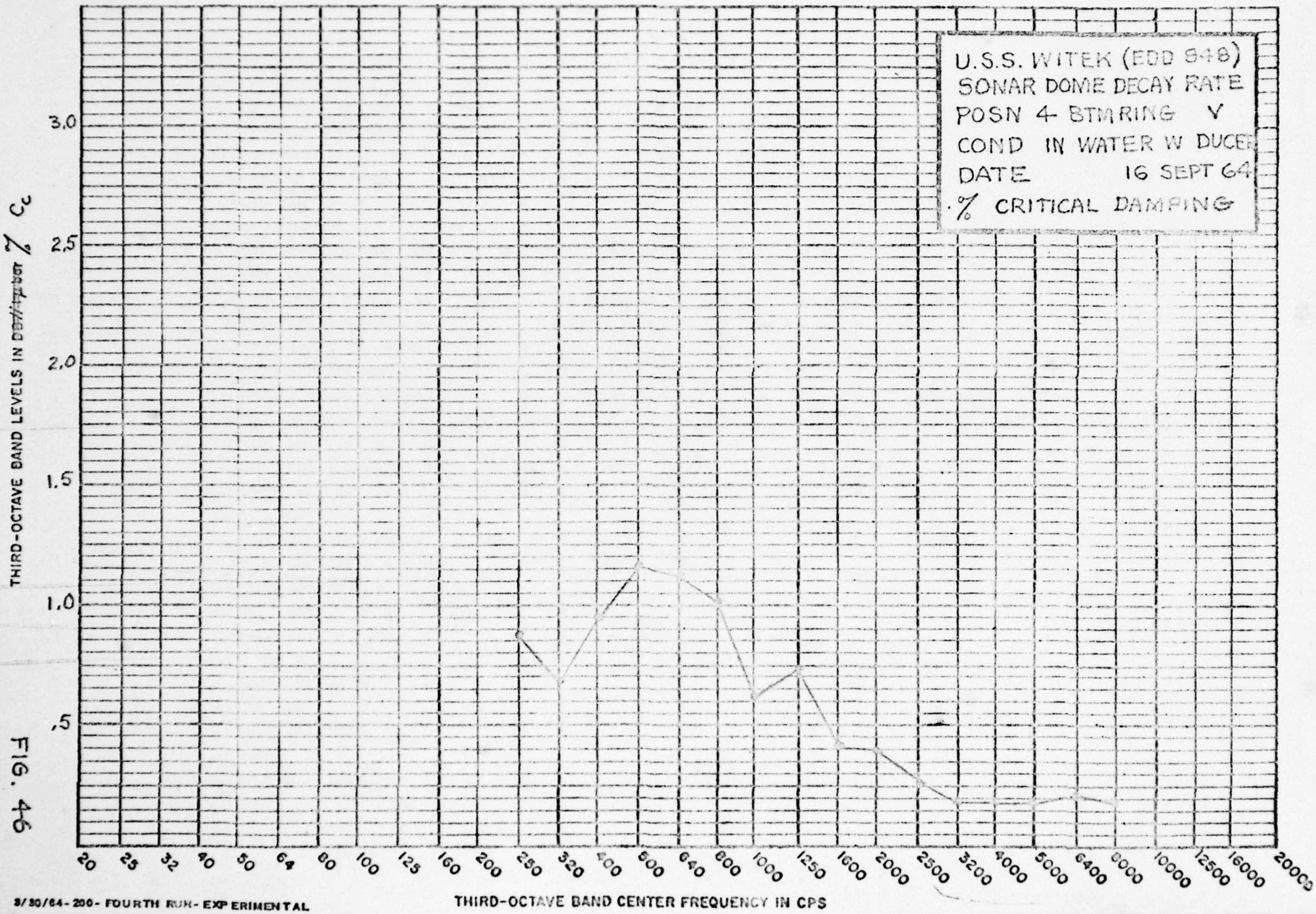


FIG. 46

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651 (Rev. 1/60)

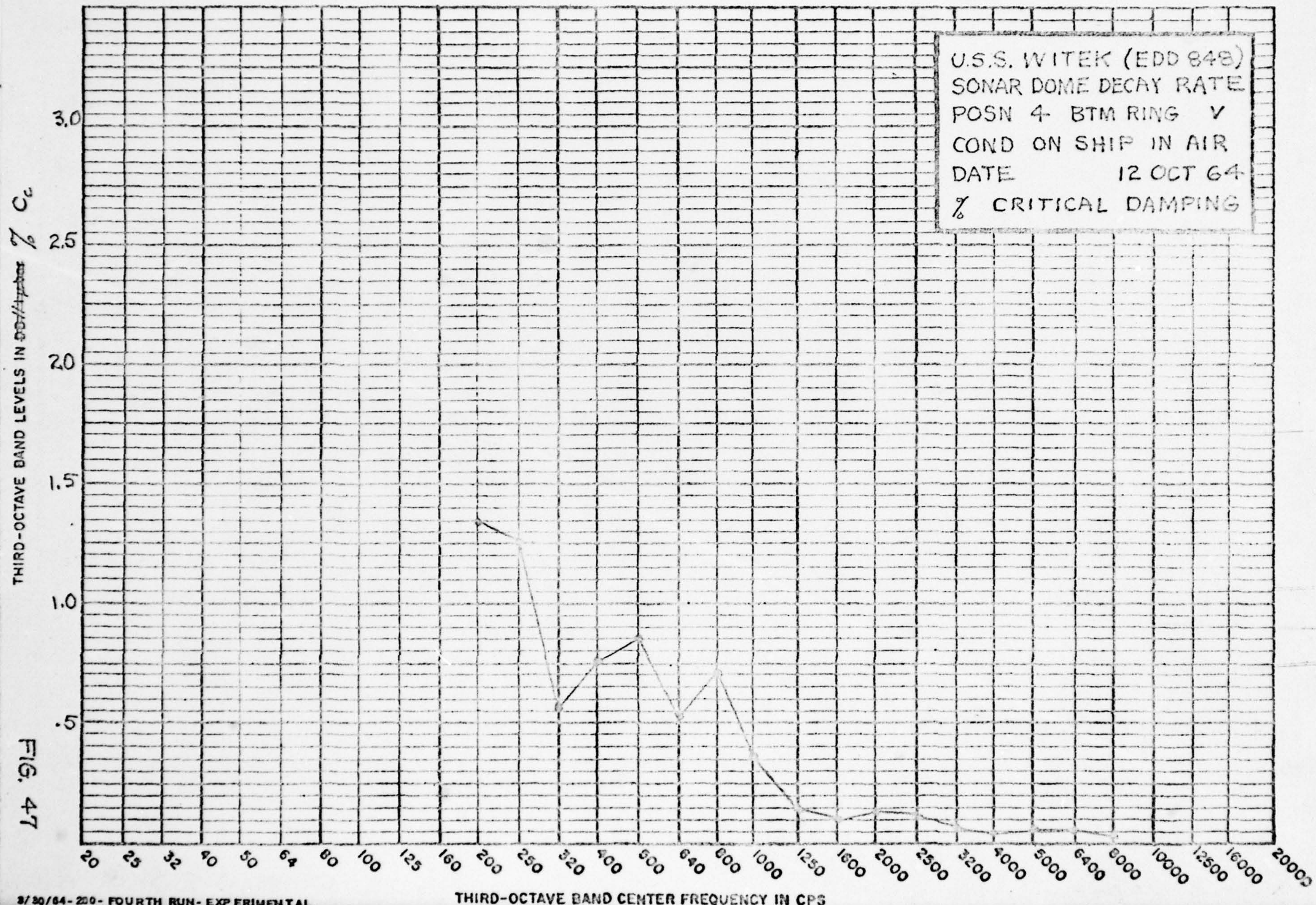


FIG. 47

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

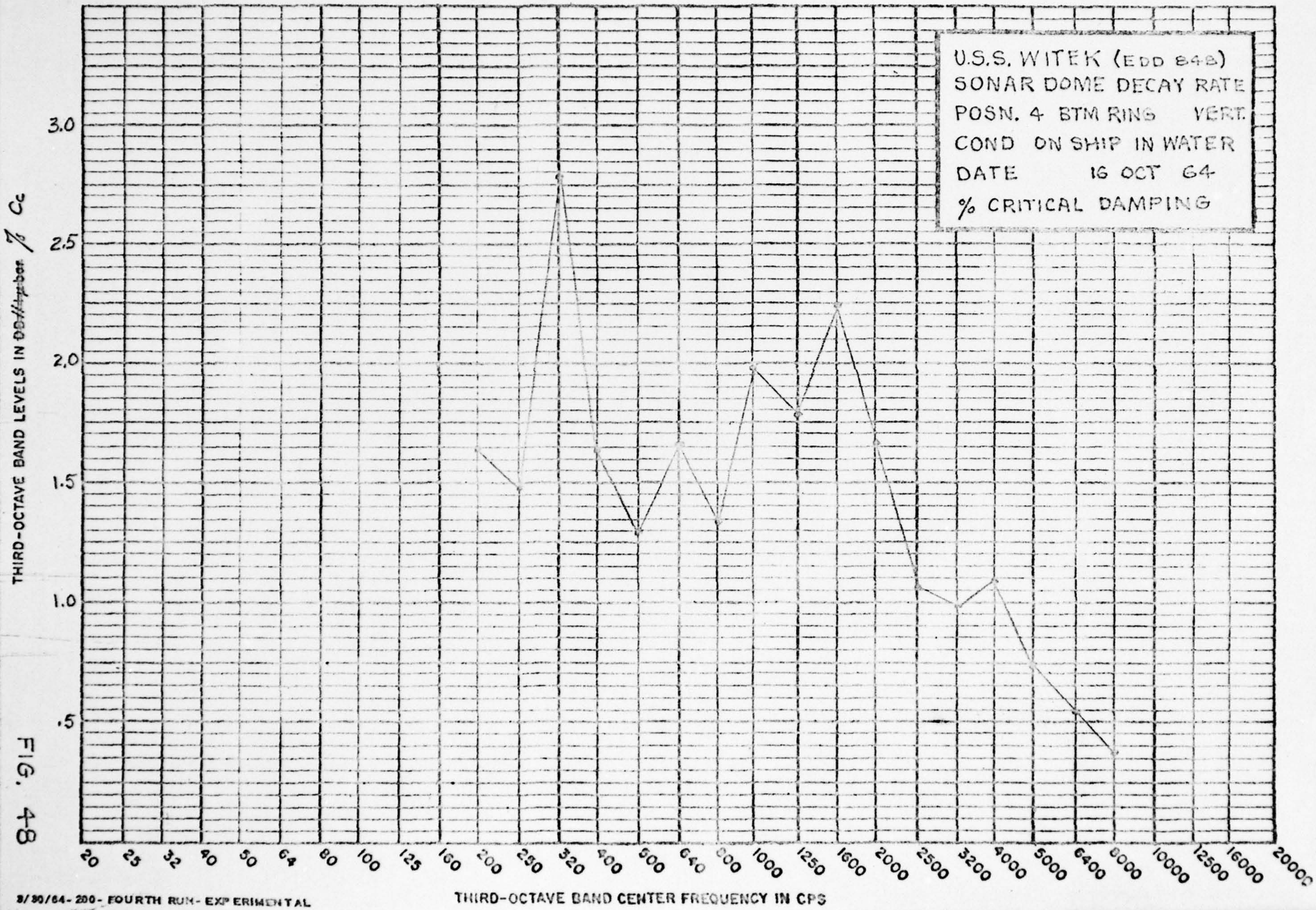


FIG. 48

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/80)

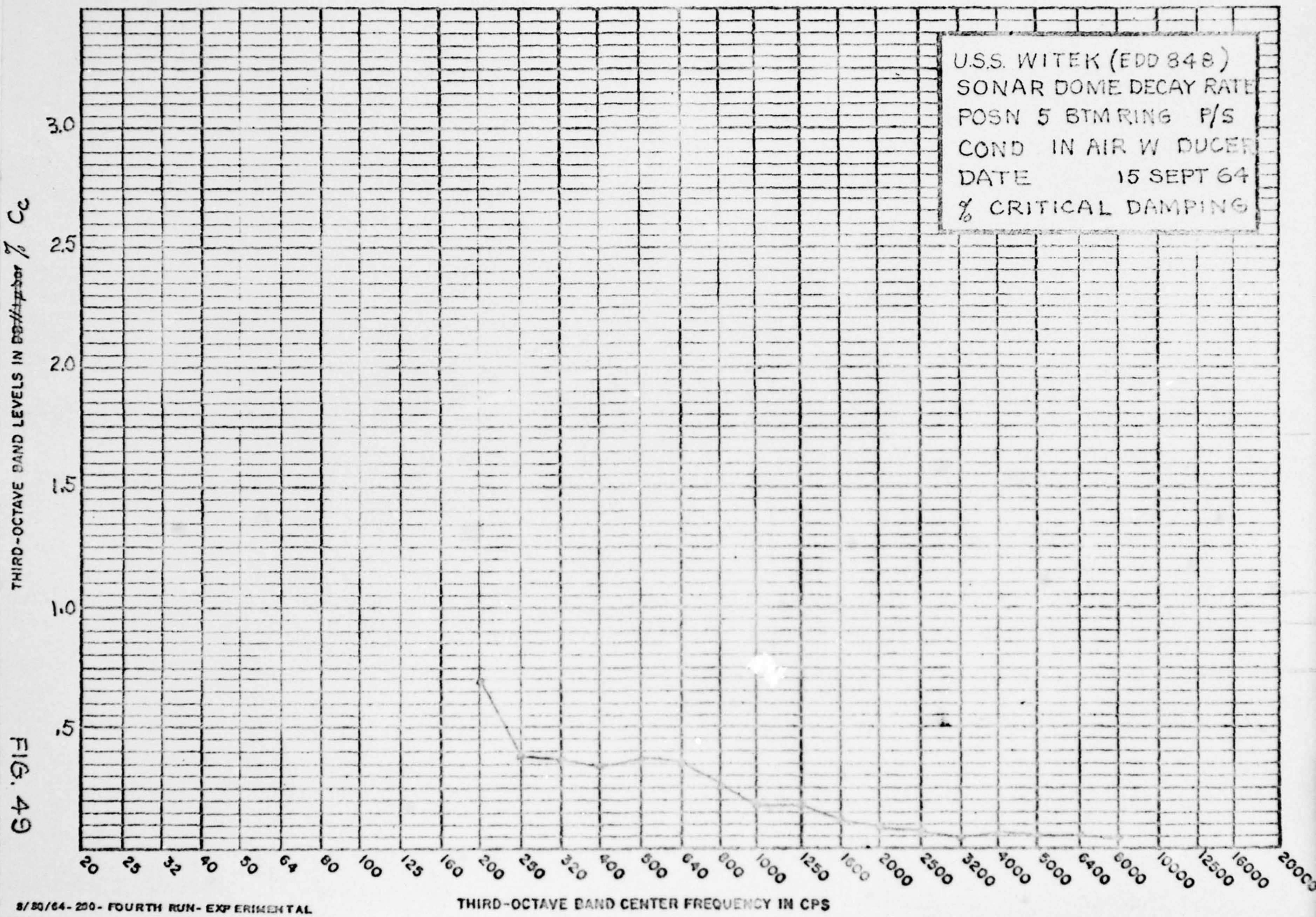


FIG. 49

8/80/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

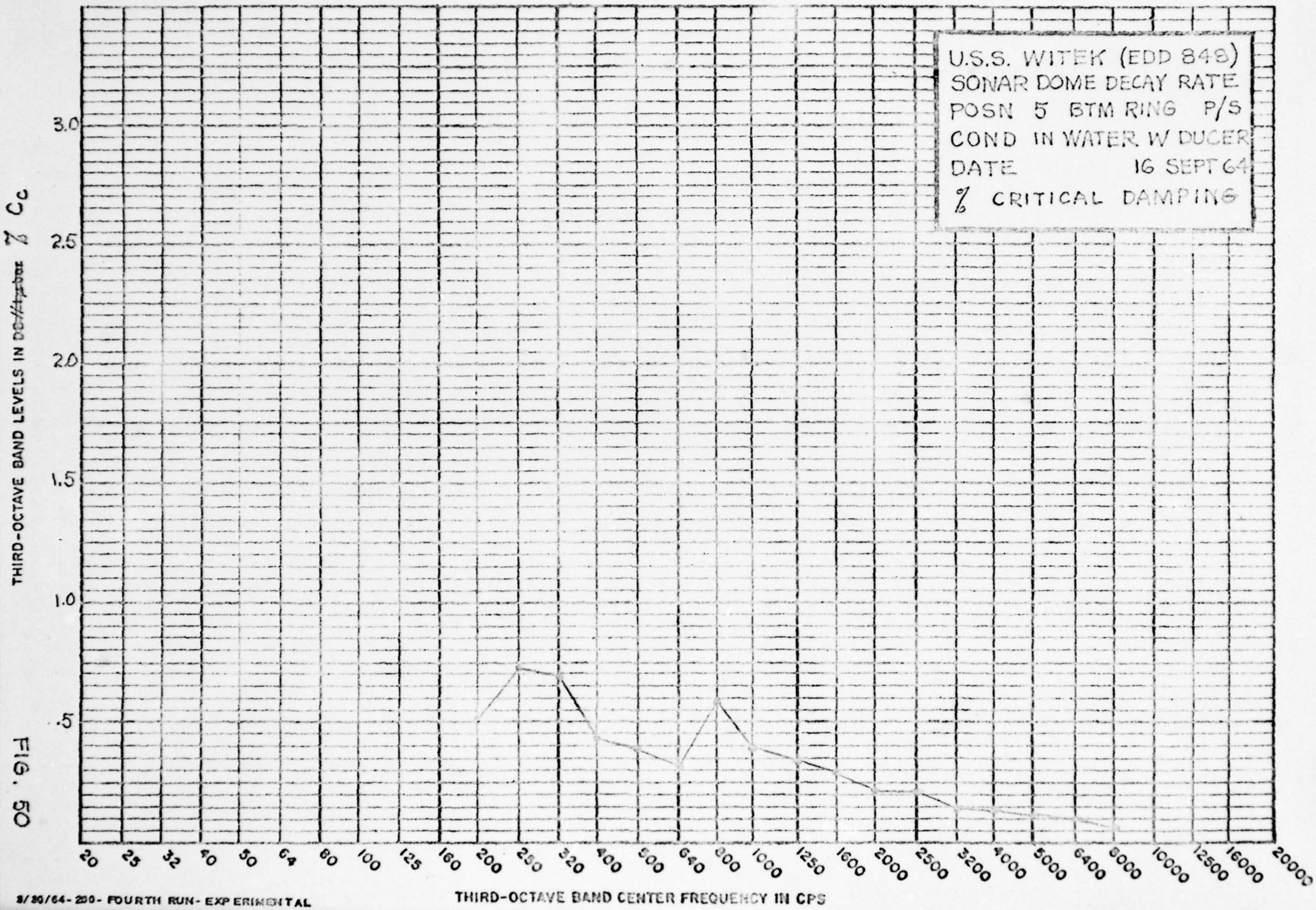


FIG. 50

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-851(Rev. 1/60)

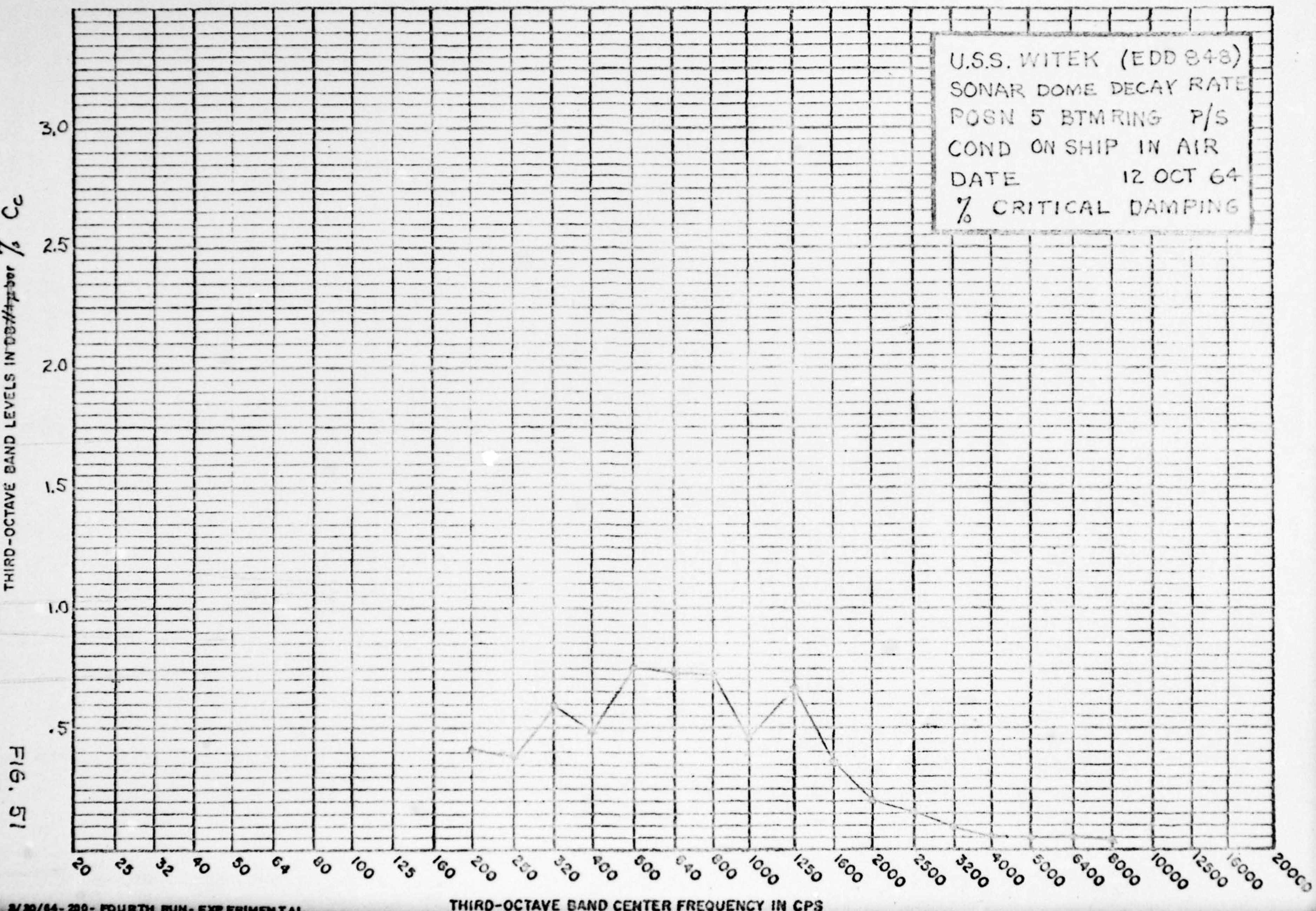


FIG. 51

8/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651(Rev. 1/60)

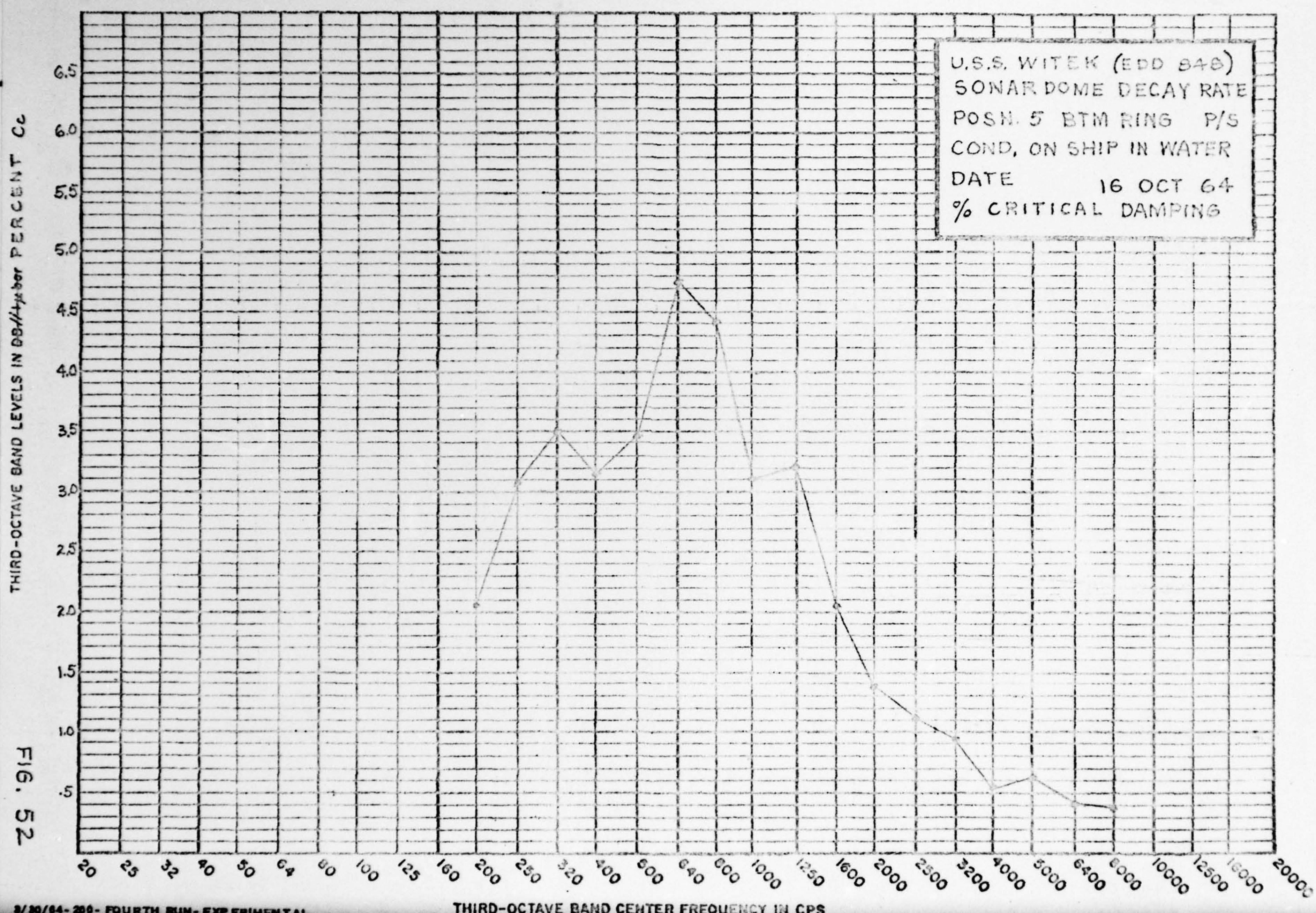


FIG. 52

3/30/64-200- FOURTH RUN- EXPERIMENTAL

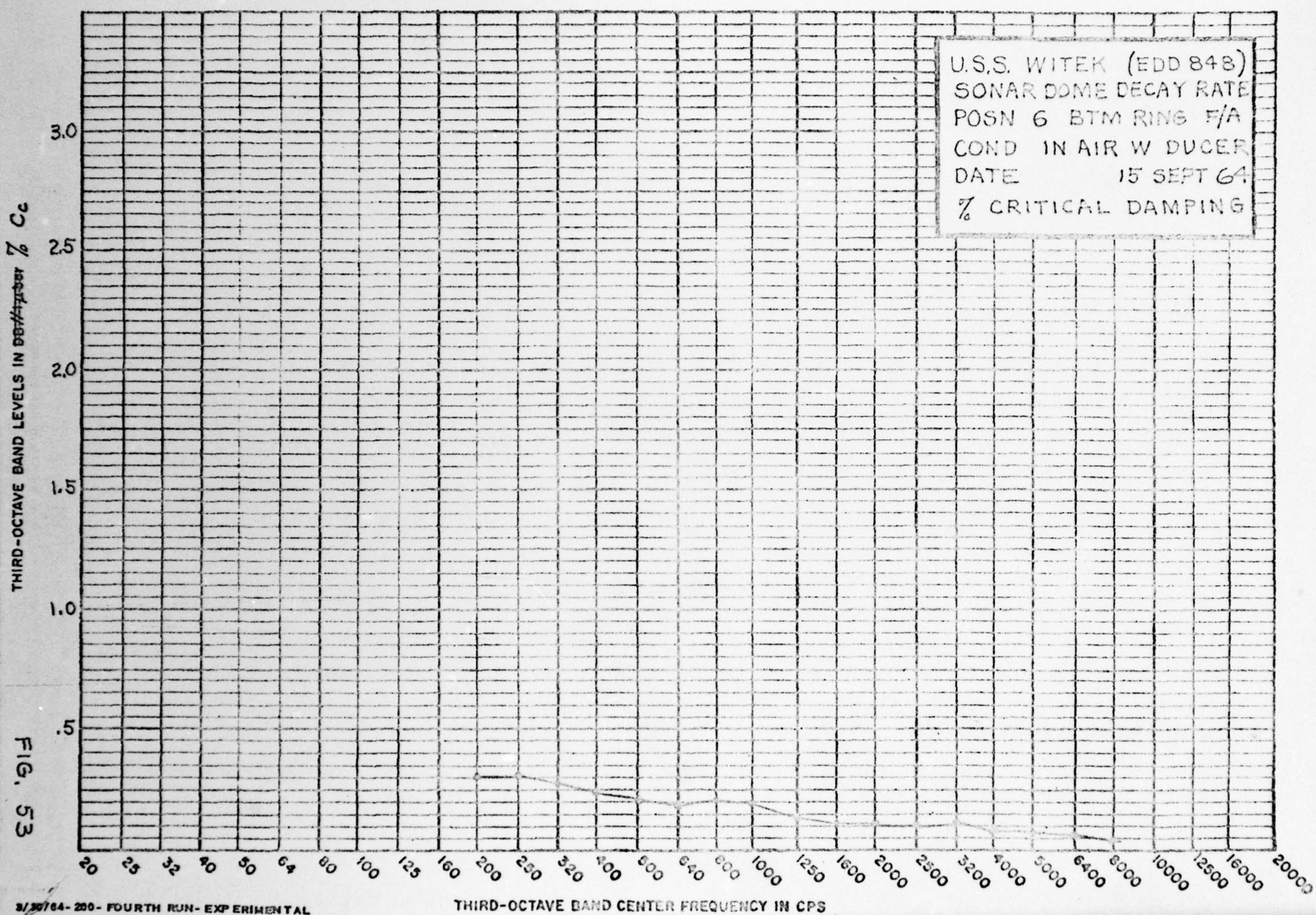

U.S.S. WITEK (EDD 848)
SONAR DOME DECAY RATE
POSN 6 BTM RING F/A
COND IN AIR W DUCER
DATE 15 SEPT 64
% CRITICAL DAMPING
THIRD-OCTAVE BAND LEVELS IN ~~DB//1µbar~~ % Cc
3.0
2.5
2.0
1.5
1.0
.5
20 25 32 40 50 64 80 100 125 160 200 250 320 400 500 640 800 1000 1250 1600 2000 2500 3200 4000 5000 6400 8000 10000 12500 16000 20000
THIRD-OCTAVE BAND CENTER FREQUENCY IN CPS

FIG. 53

USN-USL-651(Rev. 1/60)

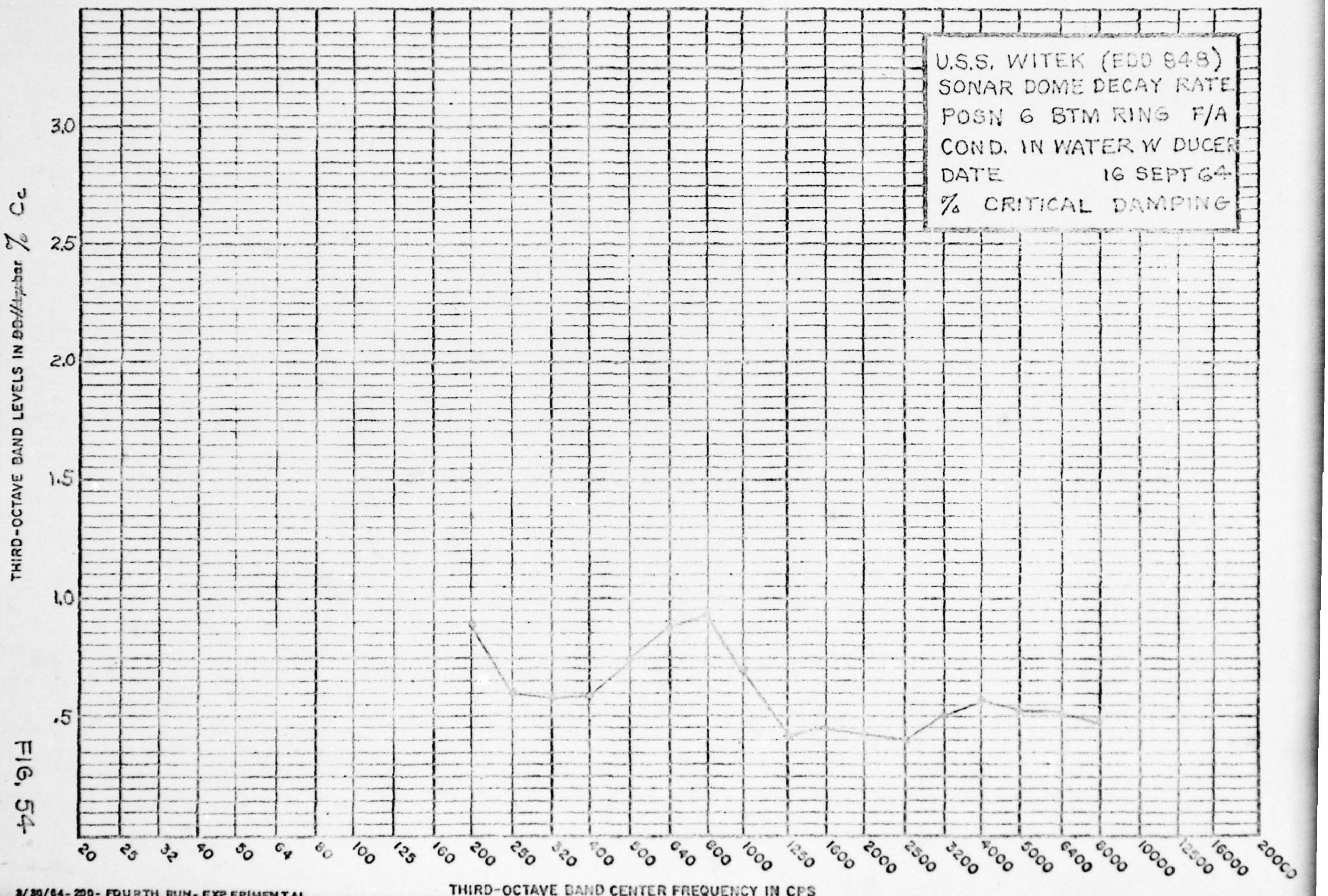


FIG. 54

3/30/64-200- FOURTH RUN- EXPERIMENTAL

USN-USL-651 (Rev. 1/60)

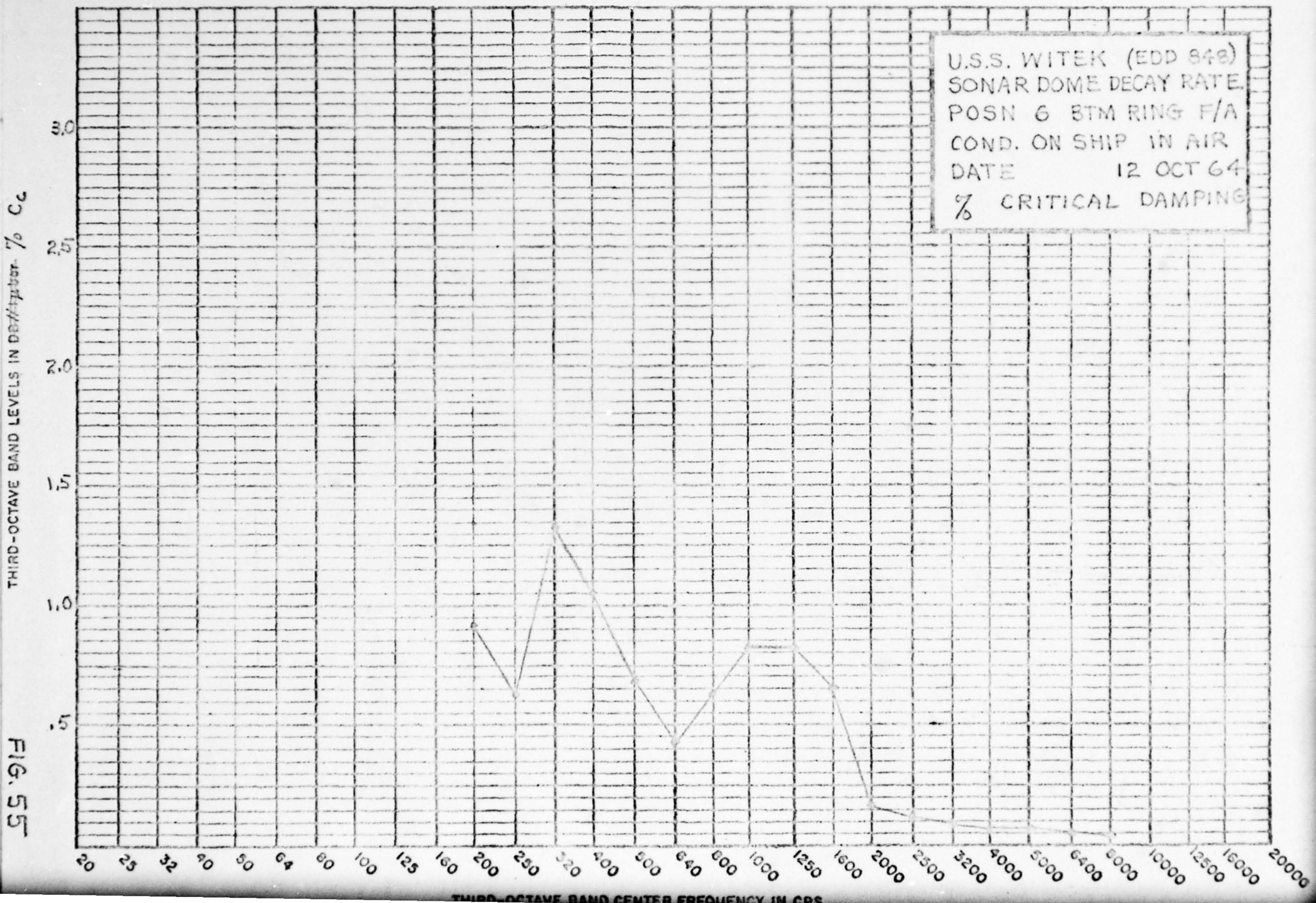


FIG. 55

USN-USL-851 (Rev. 1/60)

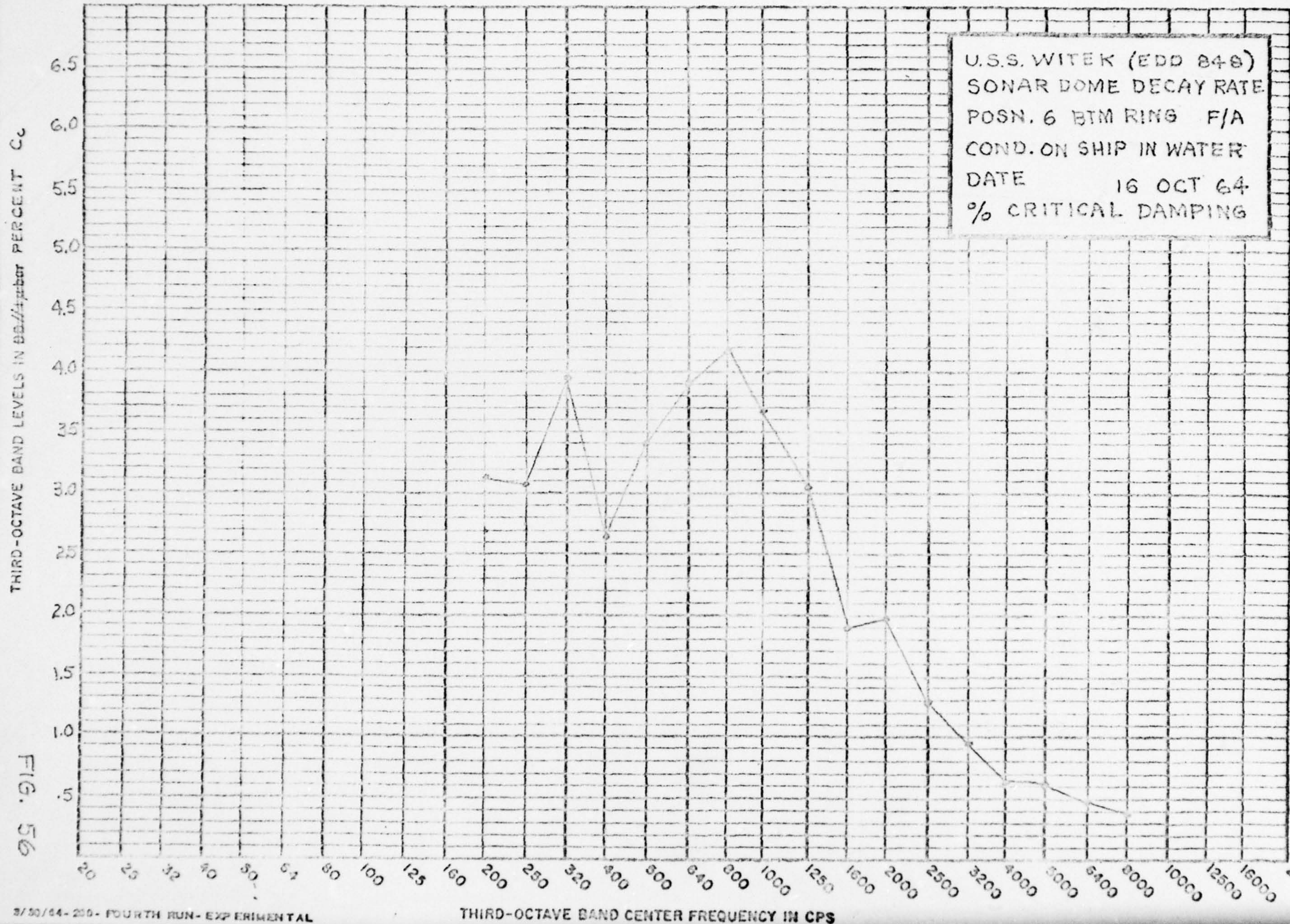


FIG. 56

3/30/64-200- FOURTH RUN- EXPERIMENTAL